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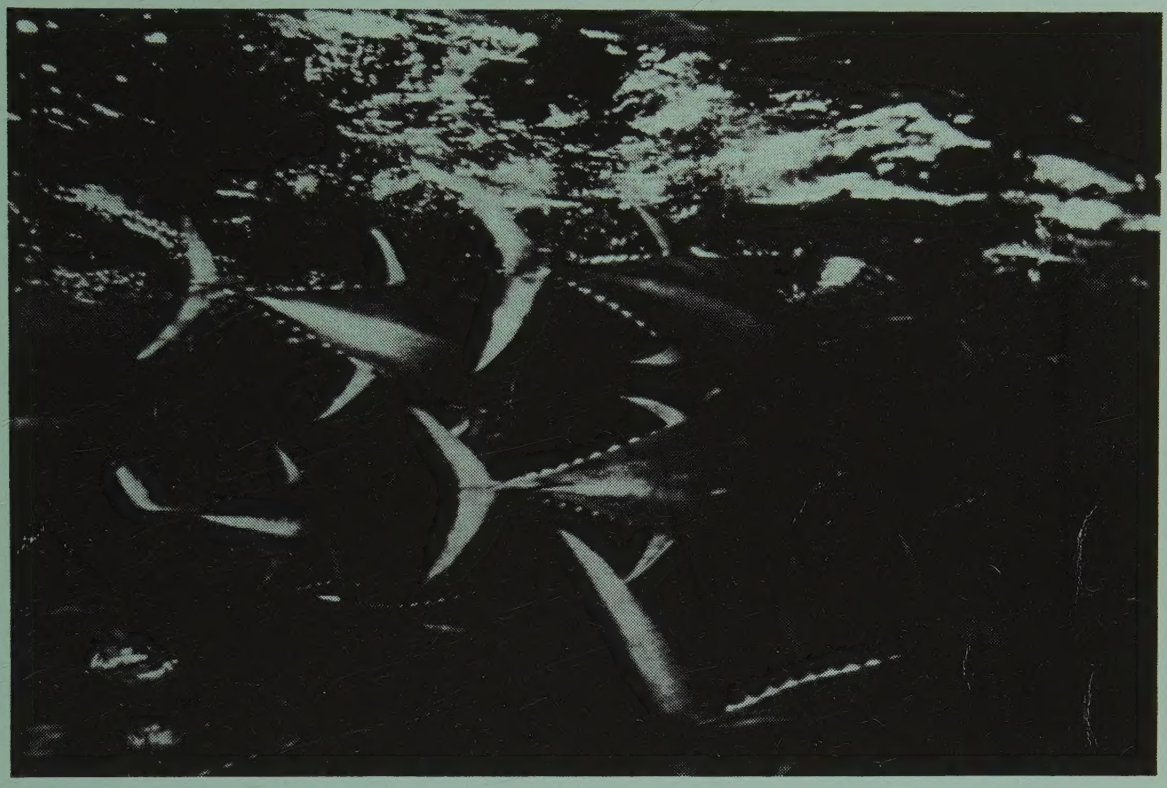

1994 Annual Report

WPFMC
Pelagics
Ann.
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1994

August 1995

Western Pacific Regional Fishery Management Council
Honolulu, Hawaii

On the Cover: School of yellowfin tuna, *Thunnus albacares*

Photo courtesy NMFS Southwest Fisheries Science Center

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Pelagic Fisheries of the Western Pacific Region

1994 Annual Report

August 1995

Prepared by the Pelagics Plan Team and Council Staff

for the

Western Pacific Regional Fishery Management Council
1164 Bishop Street, Suite 1405, Honolulu, Hawaii 96813

A report of the Western Pacific Regional Fishery Management Council pursuant to
National Oceanic and Atmospheric Administration Award No. NA47FC0026

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Pelagic Fisheries of the Western Pacific Region -- 1994 Annual Report

Introduction

Background

The Fishery Management Plan (FMP) for the Pelagic Fisheries of the Western Pacific Region was implemented by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) on 23 March 1987. The Western Pacific Regional Fishery Management Council (WPRFMC or Council) developed the FMP to manage the pelagic resources covered by the Magnuson Fishery Conservation and Management Act of 1976 and occurring in the US Exclusive Economic Zone (EEZ) around American Samoa, Guam, Hawaii, the Northern Mariana Islands, and other US possessions in the Western Pacific Region (Johnston Atoll, Kingman Reef & Palmyra Island, Jarvis Island, Howland and Baker Islands, and Wake Island).

The objectives of the Pelagics FMP were revised in 1991. The abridged objectives are to:

- Manage fisheries for management unit species to achieve optimum yield.
- Promote domestic harvest of, and domestic fishery values associated with, Pacific pelagic management unit species, or PPMUS[1] (e.g., by enhancing the opportunities for satisfying recreational fishing experience, continuation of traditional fishing practices, and domestic commercial fishermen to engage in profitable operations).
- Diminish gear conflicts in the EEZ, particularly in areas of concentrated domestic fishing.
- Improve the statistical base for conducting better stock assessments and fishery evaluations.
- Promote formation of regional/international arrangements for assessing and conserving PPMUS throughout their range.
- Preclude waste of PPMUS associated with longline, purse seine, pole-and-line or other fishing operations.
- To promote domestic marketing of PPMUS in American Samoa, Guam and Hawaii.

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[1] The Magnuson Act was amended to allow the inclusion of tunas in US fishery management authority as of January 1992. In the Pacific, tuna management is the responsibility of the regional fishery management councils. Pacific pelagic management unit species (PPMUS) includes former pelagic management unit species (PMUS) and tunas.

The Pacific pelagic management unit species (PPMUS) are[2]:

English Common Name	Scientific Name
Mahimahi (dolphinfishes)	*Coryphaena* spp.
Wahoo	*Acanthocybium solandri*
Blue and black marlins	*Makaira* spp.
Striped marlin and shortbill spearfish	*Tetrapturus* spp.
Swordfish	*Xiphias gladius*
Sailfish	*Istiophorus platypterus*
Requiem sharks (oceanic species)	family Carcharhinidae
Thresher sharks (oceanic species)	family Alopiidae
Mackerel sharks (oceanic species)	family Lamnidae
Hammerhead sharks (oceanic species)	family Sphyrnidae
Yellowfin, bigeye, albacore, and bluefin tunas	*Thunnus* spp.
Skipjack tuna	*Katsuwonus pelamis*
Kawakawa	*Euthynnus affinis*
Frigate and bullet tunas	*Auxis* spp.
Slender tuna	*Allothunnus fallai*
Dogtooth tuna	*Gymnosarda unicolor*
Mackerel	*Scomber* spp.
Moonfish[3]	*Lampris* spp.
Oilfish	family Gempylidae
Pomfret (oceanic species)	family Bramidae

Non-tuna PPMUS are sometimes referred to as "other PPMUS" in this report. This term is equivalent to the PMUS (Pelagic Management Unit Species) used in annual reports previous to 1992, before tunas were included in the management unit.

The PPMUS are caught in the troll, longline, handline, and pole-and-line (baitboat) fisheries. They are caught in oceanic as well as insular pelagic waters. Most of these species are considered to be epipelagic because they occupy the upper most layers of the pelagic zone. All are high-level predators in the trophic sense. Pelagic fisheries for PPMUS are among the most important, if not the dominant, Pacific island fisheries.

The FMP requires the Council's Pelagic Plan Team (Team) to prepare an annual report on the status of the pelagic fisheries taking place in each of the island areas served by the Council (American Samoa, Guam, Hawaii, and Northern Mariana Islands), evaluate the effectiveness of

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[2] Classifications in this table follow Amendment 6 to the FMP, effective 27 November 1992.

[3] Moonfish, oilfish, and pomfret were added to the FMP by Amendment 7, effective 24 June 1994.

the FMP in meeting its goals and objectives, and make recommendations for future management and administrative action.

Report Content

This report contains fishery performance data from each of the four island groups through 1994, interpretations of trends or important events occurring in the fisheries, and recommendations. This report was prepared using reports submitted by the following agencies. The Hawaii report is an integration of State of Hawaii and NMFS summaries.

- Territory of American Samoa, Department of Marine and Wildlife Resources
- Territory of Guam, Division of Aquatic and Wildlife Resources
- Territory of Guam, Department of Commerce
- State of Hawaii, Division of Aquatic Resources
- Commonwealth of the Northern Mariana Islands, Division of Fish and Wildlife
- National Marine Fisheries Service, Southwest Region (including Southwest Fisheries Science Center Honolulu Laboratory, Pacific Area Office, and Office of Enforcement)
- US Coast Guard, District 14
- Pacific Fisheries Research Program, University of Hawaii

Report Appraisal

Report content has not changed significantly from previous years.

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Table 1. Names of Pacific pelagic management unit species.

English Common	Scientific	Samoan or AS local	Hawaiian or HI local	Chamoru or Guam local	S. Carolinian or NMI local	N. Carolinian or NMI local
Mahimahi (dolphinfish)	*Coryphaena* spp.	Masimasi	Mahimahi	Botague	Sopor	Habwur
Wahoo	*Acanthocybium solandri*	Paala	Ono	Toson	Ngaal	Ngaal
Indo-Pacific blue marlin; Black marlin	*Makaira mazara; M. indica*	Sa'ula	A'u, Kajiki	Batto'	Taghalaar	Taghalaar
Striped marlin	*Tetrapterus audax*		Nairagi			
Shortbill spearfish	*T. angustirostris*	Sa'ula	Hebi	Spearfish		
Sailfish	*Istiophorus platypterus*	Sa'ula	A'u lepe	Guihan layak	Taghalaar	Taghalaar
Swordfish	*Xiphias gladius*	Sa'ula malie	A'u kū, Broadbill, Shutome	Swordfish	Taghalaar	Taghalaar
Moonfish	*Lampris* spp.	Koko	Opah		Lighérigher	Lighérigher
Oilfishes	*Ruvettus pretiosus; Lepidocybium flavobrunneum*	Palu-talatala	Walu, Escolar		Tekineepek	Tekineepek
Pomfret	Bramidae	Manifi moana	Monchong			
Oceanic sharks	Alopiidae; Carcharinidae; Lamnidae; Sphyrnidae	Malie	Mano	Halu'u	Paaw	Paaw
Albacore	*Thunnus alalunga*	Apakoa	ʻAhi palaha, Tombo	Albacore	Angaraap	Hangaraap
Bigeye tuna	*T. obesus*	Asiasi, To'uo	ʻAhi po'onui, Mebachi	Bigeye tuna	Toghu, Sangir	Toghu, Sangir
Yellowfin tuna	*T. albacares*	Asiasi, To'uo	ʻAhi, Shibi	Yellowfin tuna	Toghu	Toghu hangar
Northern bluefin tuna	*T. thynnus*		Maguro			
Skipjack tuna	*Katsuwonus pelamis*	Atu, Faolua, Ga'oga	Aku	Bunita	Arangaap	Hangaraap
Kawakawa	*Euthynnus affinis*	Atualo, Kavalau	Kawakawa	Kawakawa	Asillay	Hailuway
Dogtooth tuna	*Gymnosarda unicolor*	Tagi	Hagatsuo	Dogtooth or White tuna	Ayul	Owel
Other tuna relatives	*Auxis* spp.; *Scomber* spp.; *Allothunnus* spp.	(various)	Ke'o ke'o, Saba (various)	(various)	(various)	(various)

Table 2. Total 1994 pelagic landings[4] in western Pacific region.

Species	American Samoa	Guam	Hawaii	Northern Marianas	TOTAL
Mahimahi	11,048	175,183	1,000,000	11,993	**1,198,224**
Wahoo	9,000	64,595	400,000	3,090	**476,685**
Blue marlin	12,878	121,844	1,500,000	2,108	**1,636,830**
Black marlin*	1,345				**1,345**
Striped marlin			800,000		**800,000**
Spearfish*		336			**336**
Sailfish*	1,705	4,482		77	**6,264**
Swordfish			6,900,000		**6,900,000**
LL Misc. billfish			300,000		**300,000**
Yellowfin tuna	50,124	70,902	3,900,000	10,600	**4,031,626**
Bigeye			4,300,000		**4,300,000**
Albacore	1,676		1,400,000		**1,401,676**
Bluefin			40,000		**40,000**
Skipjack	148,382	207,713	1,300,000	73,769	**1,729,864**
Kawakawa*	672	1,033			**1,705**
Dogtooth	2,379	1,007		5,432	**8,818**
LL Misc. tunas	243	9	100,000	228	**100,480**
Sharks	13,317	5,093	1,800,000		**1,818,410**
Barracuda	4,696	6,124			**10,820**
Rainbow runner*	394	5,155		638	**6,187**
Moonfish			500,000		**500,000**
Pomfret*					**0**
Troll fish				9,730	**9,730**
LL Misc. pelagics			7,000		**7,000**
TOTAL	**257,859**	**663,476**	**24,247,000**	**117,665**	**25,286,000**

* NMFS Hawaii longline logbook summaries aggregate several billfish and tuna species (noted with *) into miscellaneous billfish, tuna, and pelagics categories. These miscellaneous categories are noted in the table with LL prefixes. All Hawaii totals shown here are NMFS estimates and rounded to the nearest 100,000 lb, except for bluefin tuna and LL Misc. Pelagics.

[4] Landings are reported in island reports (Appendices 1-4), which include recreational and commercial landings data, where available (e.g., for Hawaii, only commercial landings). In some cases, totals may not add precisely due to rounding.

Summary

1) The Council took several **management actions** in 1994. Amendment 7 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region established a limited entry program for the Hawaii based longline fishery by final rule (59 FR 26979)[5] on 24 June 1994. The new limited entry program replaced the previous three-year moratorium on entries to the Hawaii pelagic longline fleet. An experimental vessel monitoring program for the pelagic longline fleet was established by final rule (59 FR 58789) effective 15 December 1994. See Administrative Activities for details.

No permits were requested by any foreign nation to fish in the US EEZ of the Western Pacific region in 1994.

2) In **American Samoa**, landings and effort were apparently much higher in 1994 than in previous years. However, this was primarily due to improved supervision of data collectors which resulted in substantially larger estimates of daily participation on creel survey days, causing a corresponding increase in estimated landings. An estimated 257,859 lb were landed by pelagic fishermen in 1994. Commercial landings were an estimated 247,345 lb, with a value of $348,756. The average price for all pelagics was $1.56/lb.

The **number of boats** in the pelagic fishery was about the same as in 1993. Forty vessels made an estimated 1,738 trips, and the average trip duration was 6.6 hr/trip. Trolling was the primary method used. Catch rates for all pelagics was about the same as 1993 and catch rates for non-tuna PPMUS generally decreased, but generally increased for tunas.

Frozen fish purchased or bartered from foreign longline vessels moored in Pago Pago Harbor competed with pelagic fish landed by domestic fishermen. In some cases, Samoan fishermen acted as middlemen in the transactions between longliners and the market. Poor documentation of these transactions made it difficult to assess the impact of these exchanges on the market for fresh fish that were supplied by local fishermen. On the other hand, the market share of documented imports of pelagic fish declined from 66% of the total market in 1990 to less than 3% in 1994.

3) **Guam** landings of all pelagics (663,476 lb) decreased by 23%, total revenue rose 8% ($593,838), and adjusted revenue decreased 9%. Non-tuna PPMUS landings (-41%) and adjusted revenue (-3%) fell. Tuna landings (+24%) rose but adjusted revenue (-21%) fell. The big decrease was due almost entirely to another big fall in mahimahi landings, such as occurred in 1992. Skipjack made up 31% of the total pelagic landings, followed by mahimahi (26%), blue marlin (18%), yellowfin tuna (11%), and wahoo (10%).

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[5] 59 FR 26979 is read "*Federal Register*, Volume 59, page 26979".

Guam's adjusted **prices** have continued to decline since 1980. The decline is due, at least in part, to the entry of tunas from foreign vessels through irregular marketing channels and other marketing problems.

The estimated **number of trolling vessels** reached a record high of 328, continuing a generally rising trend. The number of trips (-5%), hours fished (-9%), and hours per trip (+2%) changed little from 1993.

Guam reported that one **domestic longliner** and 348 **foreign longliners** made 1,509 port calls and transshipped 12,283 t of fish through Guam in 1994. This included 6,554 t of yellowfin tuna, 4,896 t of bigeye, 472 t of blue marlin, and 361 t of albacore, striped marlin, swordfish, and other species. With the possible exception of eight tons landed by the domestic longliner, all of this fish was allegedly caught outside Guam's EEZ. See Fig. 16 in Appendix 2.

4) The **Hawaii** fisheries for PPMUS produced total landings for all pelagic species of 24.3 million lb in 1994, a 25% decrease from 1993. Swordfish landings (6.9 million lb) declined 47% compared to the 7% increase in 1993, the 27% increase in 1992, and the 136% increase in 1991. Swordfish continued to be the dominant species in the pelagic fishery, but only just ahead of bigeye and yellowfin tunas. Striped marlin landings decreased by 38% and was below the long-term average. Mahimahi landings rose 25% from 1993 and near the 1987-1994 average. Combined tuna landings (11 million lb) were down 8%, but catches of yellowfin, bigeye, and albacore were higher than in 1993.

Total pelagics **revenue** decreased 15% to $53.6 million and total adjusted revenue declined 17%. The inflation-adjusted ex-vessel revenue for the longline fishery fell 25%. Adjusted revenue of the troll and handline fisheries increased 18% and was significantly higher than the long-term mean.

Changes in **catch rates** for trollers varied by species in 1994. Mahimahi and yellowfin catch rates rose, while wahoo, blue marlin, and skipjack fell. Catch rates for handline generally fell, except for bigeye tuna, which reached a new record high. Baitboat catch rates of skipjack dropped 27%.

The Hawaii **longline** fleet landed 18.4 million pounds of pelagic fish, a 27% drop from 1993. Of the billfish landed in Hawaii, longlining accounted for almost all of the swordfish and striped marlin, and about half of the blue marlin. About 47% of the longline landings (approx. 8.7 million lb) were billfish (79% was swordfish). The longline fleet also accounted for most of the bigeye tuna (93%), albacore (85%), moonfish (~100%), and sharks (99%) landed in Hawaii. Estimated shark catches were much higher in 1993 and 1994 due to substantial landings of shark fins by longline vessels. A recent development for Hawaii was that bluefin tuna, *Thunnus thynnus*, were landed in 1993 and 1994 (40,000 lb in 1994) by longliners as they fished increasingly further north and west of Hawaii. Hawaii's **troll and handline** landings of pelagics increased to 5.1 million lb, higher than the long-term average of 4.7 million lb. Yellowfin tuna, mahimahi, and wahoo were the major species caught predominantly by troll and handline fishermen. **Baitboat** and troll fishermen caught almost all of the skipjack tuna.

Fishing effort for the combined pelagic fisheries in Hawaii remained at a high level in 1994. The number of longline vessels increased from around 40 in 1983-87 to nearly 140 in 1990. Then, in 1991, the number of active vessels declined to 111, as boats left the fishery and could not be replaced under the rules of a Council-imposed moratorium on new participants. In 1994, 125 vessels were active in the fishery, the highest since 1991, although the number of trips (1,107) decreased 10% and the number of hooks set (12.2 million) decreased 6%. See Appendix 3 for an explanation. The number of trips by the troll fishery increased 1% to 20,905, and though slightly higher than the 1979-94 average of 17,222, has remained almost constant since 1986. The number of trips taken by skipjack tuna baitboats (281) dropped 41% from 1993 and reached a new low. The number of handline trips (4,142) continued a decreasing trend since 1987, with a decline of 5% from 1993.

The Hawaii Department of Health **prohibited the sale of oilfishes** (walu, *Ruvettus pretiosus*, and escolar, *Lepidocybium flavobrunneum*) in March 1994. This action was taken on the recommendation of the US Food and Drug Administration, because eating oilfish may cause illness. (There is a nationwide FDA recommendation against the marketing of oilfish but, to date, there is no federal prohibition.)

5) Landings of all pelagics in the **Northern Mariana Islands** (NMI) decreased 18% to 117,665 lb, a new low. The decline in commercial landings for the last several years were due to poor skipjack tuna seasons, despite record landings of some other species. Skipjack landings were 5% lower than 1993, and only half the long-term average. Landings of mahimahi dropped 60% from the record high in 1993 and were below the long-term average. Wahoo landings rose 37% from the big drop in 1993, following the near-record 1992 landings, but were still below the long-term average. Blue marlin landings decreased 29% and were slightly below the long-term average.

Total **revenue** dropped 17% ($297,124) and adjusted total revenue fell 19%. Most of the decrease is due to lower revenues from skipjack tuna landings, which dominates the pelagic landings. Both tuna and non-tuna PPMUS revenues decreased from 1993.

The **number of fishermen** landing pelagic fish rose 22% from the low in 1993. Despite that, the number of trips landing PPMUS decreased 11%, although remaining close to the long-term average.

The **inflation-adjusted price** of non-tuna PPMUS decreased, and was below the long-term average. The adjusted price of tunas also decreased and was on the 11-year average. The adjusted revenues per trip stabilized after the record lows in 1993 but still well below the long-term averages.

6) The **swordfish** longline fishery in Hawaii began in 1989 with landings estimated at 0.6 million lb, increasing to 3.4 million lb in 1990, and peaking at 13.5 million lb in 1993. There was a drop to 6.9 million lb in 1994 due to lower catch rates and lower effort. The average size of swordfish dropped to 160.5 lb, but remained larger than in 1987-91. Swordfish comprised the largest proportion of the total non-tuna landings by all fisheries in Hawaii for the fifth consecutive year (60% in 1994, 72% in 1993, 73% in 1992, 62% in 1991, and 38% in 1990). Swordfish landings

from non-longline gear were negligible in comparison. Other areas did not report landings of swordfish.

7) In American Samoa, **blue marlin** landings reached a new peak of 14,223 lb. Guam landings of blue marlin (121,844 lb) were 23% higher in 1994, ranking third behind mahimahi and skipjack tuna. Blue marlin landings (1.5 million lb) in Hawaii were about the same as 1993, maintaining a stable level since 1990. Longlines accounted for 54% of the total blue marlin landings. Blue marlin landings in the Northern Marianas (2,108 lb) decreased 29% from 1993 and was below the 12-year mean.

The catch rate of blue marlin in the American Samoa troll fishery dropped from 1993's record high but was still relatively high. In Guam, blue marlin troll catch rates increased but did not reach the record high 1990-91 levels. The catch rate of blue marlin in the Hawaii troll fishery decreased slightly, but was within the long-term average. In the Northern Marianas, the 1994 marlin catch rate dropped below the 12-year average of 1.90 lb/trip.

The average size of blue marlin in the Guam International Fishing Derby was about the same as 1993 at about 148.6 lb.

8) **Striped marlin** landings ranked third among the billfish in Hawaii (after swordfish and blue marlin), where it accounted for 6% of the commercial landings of non-tuna PPMUS. The 1994 landings of 0.8 million lb were 38% lower than 1993 landings and lower than the 1987-94 average. Striped marlin is regarded as a secondary target species (after bigeye tuna) in the winter longline fishery, and it tied for second with blue marlin after swordfish in total longline landings of billfish. Landings in the Hawaii troll and handline fisheries dropped back to the long-term average. The species rarely appears in the domestic landings from other areas.

9) **Shortbill spearfish** made up less than 1% of the PPMUS landings in Hawaii, and rarely appeared in the landings reported for other areas. Black marlin and other miscellaneous billfish were rare in all fisheries.

10) **Sailfish** landings were insignificant in all areas.

11) **Mahimahi** landings (11,048 lb) in American Samoa almost reached the peak set in 1986. Guam's mahimahi landings fell (175,183 lb) after the record high of 423,988 lb in 1993. The trolling catch rate also dropped substantially from 1993. Mahimahi landings (1.0 million lb) made up 8% of the 1994 non-tuna PPMUS landings in Hawaii, a 25% increase from 1993. The longline fishery accounted for 38% of the 1994 landings. The troll catch rate in Hawaii increased and was above the long-term average. Northern Marianas mahimahi landings decreased to 11,993 lb, or 52% of the non-tuna PPMUS landings. The trolling catch rate decreased 57% and was well below average.

12) **Wahoo** landings in American Samoa (9,000 lb) were at a new high, but the catch rate dropped 36%. Guam's wahoo landings (64,595 lb) decreased by 33% and catch rates followed a similar trend. Wahoo landings in Hawaii for 1993 (0.4 million lb) decreased about 20% from

1993, and was near the 1987-94 average. The trolling catch rate data for Hawaii decreased 19% and was below average. Northern Marianas wahoo landings (3,090 lb) increased 37% but was still below the long-term average.

13) Estimated Hawaii **shark** harvests in 1993 and 1994, were much higher than previous years (1.8 million lb in 1994). The increase is due to new estimates derived from landings of shark fins, mainly by longliners. Shark landings from other areas were relatively minor.

14) **Yellowfin tuna** landings in American Samoa (80,124 lb) almost reached the peak level of 1984, although catch rates were a little lower than 1993. Guam yellowfin landings (70,902 lb) decreased 7% but the catch rate was slightly higher. Catch rates have stabilized since about 1986 at a new lower level than the previous period. Total Hawaii landings of yellowfin (3.9 million lb) were about the same as 1993 and slightly higher than the 1987-94 average. Higher landings were made by trollers and handliners than by longliners. The trolling catch rate dipped (-17%) as did the handline catch rate (-11%) but was still relatively high. NMI yellowfin landings were slightly lower (-11%, 10,600 lb) than 1993 and below the 12-year mean. Catch rates were 58% lower as well and much below average. Yellowfin have never been a major component of NMI tuna landings.

15) **Skipjack tuna** landings in American Samoa in 1994 (148,382 lb) almost reached the record peak of 1988. The catch rate was 26% higher. Guam skipjack landings (207,713 lb) and catch rate were much higher than 1993. Hawaii skipjack landings (1.3 million lb) were much lower than 1993 and were caught mainly by baitboats. The troll skipjack catch rate was 17% lower than 1993, and the baitboat catch rate was 27% lower than 1993. NMI's 1994 skipjack landings were 5% lower (73,769 lb) than 1993, and has continued a steep decline since 1989. Although the catch rate rose 7% from 1993, it was still far below the 1983-94 mean.

16) Hawaii landings of **bigeye tuna** (4.3 million lb) were slightly higher than 1993, almost all caught by longline. No other areas reported bigeye landings.

American Samoa reported landing 1,676 lb of **albacore**. Hawaii total landings of albacore increased 18% and reached a new peak (1.4 million lb). About 85% of albacore were landed by longliners. Other areas did not report landings of albacore.

17) **Troll fisheries** dominated the domestic fisheries in American Samoa, Guam and the Northern Marianas, in contrast to Hawaii where the longline sector caught more PPMUS than the other sectors. Growing charter fishing businesses in Guam and Northern Marianas contributed heavily to troll fishing effort. There were no domestic longliners operating in American Samoa, Guam, or Northern Marianas in 1993, and pelagic handline fishing has not been established in any areas other than Hawaii.

Issues

The effect of "gray market" fish in Guam and American Samoa on the marketing of pelagic fish, and the resulting impact on fishermen's behavior, is still undetermined. Team members suspect that fish obtained from foreign longliners or purse seiners and sold in the retail markets are having an adverse effect on prices of locally caught pelagic fish, especially in Guam, and are depressing local fishing activity.

Inadequacy of fisheries data remains a problem, especially in Hawaii. There are still no current or long-term historical estimates of landings by non-commercial fishermen in Hawaii and true effort information is lacking in commercial catch data. American Samoa landings increased sharply in 1994, primarily due to improved supervision of data collectors. Although the improvement in landings data is welcome, it makes comparisons with previous years problematic.

Recommendations to the Council

1) An analysis of the Hawaii swordfish longline fishery in the North Pacific is needed. The analysis should discuss the declines in total catch and CPUE in detail. A special report on this fishery should be included with the 1995 annual report.

2) The Council and/or other appropriate agency should seek funding to conduct, under the Pelagic Fisheries Research Program, a survey of Hawaii small-scale fisheries. This survey is needed to evaluate the significance of non-commercial and part-time components of these fisheries. The survey would build on a pilot small boat creel survey conducted in 1991.

3) The Council should request the HDAR to develop and implement a fish dealer permitting system, and should computerize and enforce its dealer reporting system. This will further document the total volume of fish sold in the state, and will provide a cross-reference validation capability for fishermen's reports.

4) The appropriate agency or agencies should use the information gained during studies related to recommendations 2 and 3 above, and evaluate their usefulness for management of Hawaii's pelagic fisheries.

5) The HDAR should improve the collection of fisheries data so that the data provide useful information on fishing effort. They should enter into the database all information that is reported on forms, especially header information that would identify the beginning and end of multi-day trips.

6) The three fishery management councils with Pacific jurisdictions, along with member states and the NMFS, should collaborate to ensure the collection of landing and logbook data from all domestic longline and driftnet vessels harvesting swordfish and other Pacific Pelagic Management Unit Species (PPMUS).

7) The Council should support an analysis of trends in mahimahi and wahoo landings and catch rates throughout the region, particularly in the western Pacific, and including data from EEZ and distant-water fisheries. Mahimahi is an important resource and economic component of island fisheries.

8) The appropriate island agencies in American Samoa, Guam and the Northern Marianas should investigate motivational factors relating to pelagic fishing effort, and incorporate this information into future annual reports. This information will expand and improve the interpretation of patterns in participation and effort.

9) The Team should include a discussion of the impacts on the respective local markets of distant water pelagic fleets that are based in each area.

10) The Council should attempt to obtain data on the total effort and catch by species, including discards, from US and other purse seine fisheries within the US EEZ and on the high seas.

Plan Administration

Administrative Activities

There were two key administrative activities undertaken by the NMFS Southwest Region during 1994: Amendment 7 to the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region and experimental electronic vessel monitoring system in the Hawaiian longline fishery. The Southwest Region prepared two final rules for approval by the Secretary of Commerce and publication in the *Federal Register*:

> 25 May 1995 (59 FR 26979) - Final Rule (effective 24 June 1994). This rule, which implemented Amendment 7, established a permanent limited entry program for the Hawaii longline fishery for pelagic species replacing a three-year (1991-94) moratorium on new entry to the fishery. Key provisions of this program include freely transferable permits, upgrading of vessels to a maximum of 101 ft in total length, and framework procedures facilitating revisions to regulatory measures for timely and effective management of the fishery.
>
> 15 November 1994 (59 FR 58789) - Final Rule (effective 15 December 1994). An experimental vessel monitoring program was established for the Hawaii longline fishery using an electronic vessel monitoring system (VMS). All vessels in this fishery, upon notification from NMFS, must carry vessel monitoring equipment owned and installed by NMFS.

In addition to the final rules, the Southwest Region also prepared for approval and publication a Notice of Availability (59 FR 4898), a Proposed Rule (59 FR 9050), and a Correction (59 FR 28449) for Amendment 7, a Proposed Rule (59 FR 40359) for the vessel monitoring program, and a Technical Amendment (59 FR 46939) for the longline area closure around Guam.

Longline Permits

The Southwest Region (Pacific Area Office) administered the new Hawaii longline limited entry permits program under Amendment 7. By 22 September 1994, the cut-off date for receipt of permit applications[6], 163 permits were processed and issued to longline vessel owners. Four vessel owners who previously had held moratorium permits were not issued permits for continued participation in the fishery due to non-submission of permit applications or for not landing longline-caught fish at least once during the moratorium period.

As authorized under Amendment 7, the NMFS began the collection of application fees for Hawaii longline permits, including permit transfers. An initial fee of $33.00 per application was assessed all applicants. In 1994, the Southwest Region collected a total of $6,435 for permit application fees[7] which were deposited in the US Treasury.

The Southwest Region processed 27 longline limited entry permit transfers during 1994, more than double the number of permits transferred (13) in 1993. This increase was the result of Amendment 7 which allowed for free transferability of permits beginning 24 June 1994. Under the previous three-year longline moratorium program, a permit holder was restricted to a one-time only transfer of his or her permit to another vessel owner.

Although Amendment 7 allows vessel owners to upgrade their vessels to a maximum overall length of 101 ft, the median length of the longliners at the end of 1994 was 70 ft, about the same as the median length of vessels (68 ft) prior to implementation of the amendment.

No administrative actions relating to foreign fishing in the western Pacific EEZ were required because no foreign fishing permits were requested for any vessels with which the USA has a Governing International Fishing Agreement.

Protected Species Conservation

A mandatory observer program was required by the Biological Opinion and Incidental Take Statement that were issued in June 1993, regarding the take of sea turtles in the Hawaii longline fishery. The observer program was implemented by regulations published in December 1993, and the NMFS began placing observers on longline vessels in February 1994. The NMFS placed observers on 55 longline trips in the first 12 months of the program (24 Feb 94 to 23 Feb 95). The observed effort was 599,700 hooks set, and 38 interactions were observed. The cumulative interaction rate was 0.063 interactions per 1,000 hooks set. No turtles were observed to be dead on retrieval of the gear. As required by the 1994 Biological Opinion (see below), the Southwest Region prepared a report that summarizes data collected by observers in the first 12 months of the

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[6] On 20 May 1994, pre-printed application forms were sent to all current longline limited entry permit holders informing them of Amendment 7 and their need to apply for new permits to prevent any interruption to fishing activities.

[7] Includes fees collected in fiscal year 1995 (beginning October 1994); for FY95, the fee for each Hawaii longline permit application was determined to be $39.00 by the Office of the Comptroller, NOAA.

mandatory program, and reviews other progress in carrying out the Biological Opinion. The report was released in June 1995.

Another Biological Opinion and Incidental Take Statement (Opinion) were issued in July 1994 concerning the take of sea turtles in the longline fishery based in Hawaii. The Southwest Region convened a workshop with Honolulu Laboratory and Council staff in September 1994 to seek agreement on actions needed to comply with terms of the Biological Opinion. A report on the workshop was prepared and distributed to all participants.

Working with the Honolulu Laboratory, observer program staff developed and implemented new protocols for such activities as tagging and releasing turtles and taking biopsies for analysis of genetic tissue. Observer program staff also participated in a workshop dealing with turtle handling techniques to determine measures to reduce or mitigate the effects of interaction with longline gear.

Habitat Issues and Activities

There is no information to suggest that the habitat of pelagic management unit species was subjected to major alterations in 1994. The continuing introduction of low-level pollution from diverse sources, however, combined with occasional pulses at higher levels, is an ongoing problem. Pollution sources include runoff from high islands, sewage from island outfalls and ships, oil from ship bilges and accidental spills, and marine debris originating from land or ships in the region, or drifting in from other areas.

In October 1993, the Taiwanese longline fishing vessel *Jin Shiang Fa* ran aground on the reef along the western side of Rose Atoll, American Samoa. The vessel spilled an estimated 100,000 gal of diesel fuel, 500 gal of lube oil, and 2,500 lb of ammonia. In November, NMFS participated in a multi-agency Natural Resource Damage Assessment of the atoll. Damage from spilled fuel products and physical damage from the vessel and gear was documented within the lagoon and on the outer atoll reef to a depth of 150 ft. A plume of oil extended from the wreck site out into the pelagic environment. Follow-up damage assessment continued in 1994 with two additional cruises.

The Marine Spill Response Corporation (MSRC) recently set up operations in Hawaii to respond to large oil spills in the Pacific islands. Their new top-of-the-line spill recovery vessel, the *Hawaiian Responder*, is based in Honolulu Harbor. MSRC will handle spills greater than 1,250 bbls and the local cooperative, Clean Islands Council, will handle smaller spills with their vessel.

Ocean dumping of waste from the two tuna canneries in Pago Pago, American Samoa, is authorized under special permits from the US Environmental Protection Agency. The Council and NMFS continue to receive and review routine reports on the dumping program. No significant adverse impacts have been identified.

The potential threat to pelagic habitat is reviewed through the Council's Ecosystems and Habitat Committee. The Council maintains a Habitat Policy that ensures that each FMP includes all available information on habitat significant to the management unit species.

Enforcement Activities

The following report is a combined effort of the US Coast Guard (USCG) 14th District and the National Marine Fisheries Service (NMFS) Southwest Region Office of Enforcement. The report covers the period from 1 January to 31 December 1994.

The USCG conducted 944.4 hours of fisheries patrols with C-130 aircraft in the central and western Pacific region during 1994. The C-130 surveillance of US EEZs was broken down as follows:

264.8 hr in the Main Hawaiian Islands,
232.7 hr in the Northwest Hawaiian Islands, including Hancock Seamount,
84.8 hr in Guam and the Northern Mariana Islands (NMI),
26.9 hr in American Samoa,
143.6 hr in Palmyra/Kingman Reef,
79.1 hr in Jarvis,
34.4 hr in Howland/Baker, and
23.4 hr in Wake.

There were also 54.7 hr expended on high seas driftnet enforcement. The Coast Guard flew 462.8 hr with HH-65 helicopters in support of fisheries law enforcement, concentrated in the Main Hawaiian Islands. During 1994, 47 high endurance cutter days were utilized patrolling District 14 waters.

In 1994, some 640 fishing vessels were sighted within District 14 boundaries. Of these vessels, 134 were boarded: 98 from the USA, 15 Japan, 10 Taiwan, 9 South Korea, 1 Honduras, and 1 Belize.

There were three significant MFCMA law enforcement cases relating to pelagic fisheries that were prosecuted by the Coast Guard in 1994:

1. On 03 August 1994, the domestic pelagic longliner *Capt T&T* was sighted fishing inside the MHI longline closure area. The *Capt T&T* was subsequently boarded by the USCGC *Munro*. The vessel's voyage was terminated, and the vessel was escorted to Honolulu. The final court resolution regarding this case is still pending.

2. On 28 August 1994, USCGC *Mallow*, with assistance from an Air Station Barbers Point C-130, intercepted and boarded the Korean longliner *Haeng Bok No. 309* northeast of Kwajalein Atoll, RMI. The *Haeng Bok No. 309* was known to have fished inside the US EEZ of Jarvis Island from June through August 1994. When onboard *Haeng Bok No. 309*, Mallow's boarding team located incriminating documentation that confirmed the

vessel had fished inside the US EEZ. The *Haeng Bok No. 309* was subsequently seized and escorted to Guam. The case resulted in a $1,008,000 fine for the vessel's owner, and the requirement for all 17 vessels in the Haeng Bok fleet to carry satellite transponders during the next five years.

3. On 10 October 1994, a Coast Guard C-130 sighted the Taiwanese longliner *Jin Chun Tsai No. 16* twenty-three nautical miles inside the southeastern corner of the US EEZ of the NMI; the vessel appeared to be fishing at the time. USCGC *Galveston Island* was dispatched to the vessel's last known position; additional C-130 flights were flown in an attempt to locate the longliner. Unfortunately, the longliner was not relocated and, thus, could not be boarded.

Within the Coast Guard Marianas Section, located in Guam, numerous foreign fishing vessels were boarded dockside. As a result of these boardings, several Lacey Act cases were documented. All of the vessels were pelagic longliners, and most violations related to the unauthorized setting of gear within a particular nation's EEZ, or fishing without a current permit. The following information applies to Lacey Act cases prosecuted in the Marianas Section.

Vessel Name	Flag	Date	EEZ Violated
Hou Chun No. 11	Taiwan	Nov 94	Solomon Islands
Oryo Maru	Japan	Nov 94	Papua New Guinea
Pacific Rainbow	Belize	Nov 94	Papua New Guinea
Eiju Maru No. 11	Japan	Sep 94	Papua New Guinea & Federated States of Micronesia
Tokuei Maru No. 8	Japan	Aug 94	Papua New Guinea & Federated States of Micronesia
Shinsei Maru No. 1	Japan	Aug 94	Papua New Guinea
Yuh Fuh Chuen	Taiwan	Jul 94	Papua New Guinea
Cheng Fa Tsai	Taiwan	Jul 94	Papua New Guinea
Charito	USA	Jun 94	Palau & Federated States of Micronesia
Juventus	S. Korea	Jun 94	Papua New Guinea
Kaien Maru No. 33	Japan	May 94	Papua New Guinea
Heung Young No. 17	S. Korea	May 94	Kiribati
Kiticho Maru	Japan	Mar 94	Papua New Guinea
Yuri Maru No. 11	Japan	Mar 94	Papua New Guinea
Jin Torng Long No. 612	Taiwan	Jan 94	Federated States of Micronesia

The Hawaii longline Vessel Monitoring System (VMS) program began installing shipboard transceivers in June 1994. Under this three-year pilot program, vessels operating in the pelagic longline fishery around Hawaii must carry vessel monitoring equipment owned and operated by NMFS. With this equipment, a vessel can be identified and its location monitored by satellite. Such information will be used by NMFS and the USCG to enforce regulations that prohibit fishing in closed areas. The Vessel Monitoring System Control Center became operational on 15 December 1994. It is operated by the NMFS and is located in the Joint Rescue Coordination Center of the USCG District 14 Office in Honolulu, Hawaii. As of December 1994,

approximately 75 vessels have operational VMS equipment on board with more installations scheduled for 1995. During the three-year VMS program, the Western Pacific Fishery Management Council and NMFS will evaluate the performance and cost-effectiveness of VMS and make recommendations regarding the future use of VMS in this and other fisheries.

Appendix 1

Territory of American Samoa

Introduction

The pelagic fishery in American Samoa has been an important component of the domestic commercial fishery since the early 1970s. The island of Tutuila is also a major base for the trans-shipment and processing of foreign tuna. The domestic pelagic fishery is monitored by the Department of Marine and Wildlife Resources (DMWR), through a program established in conjunction with the Western Pacific Fishery Information Network. Prior to 1985, only commercial landings were monitored. From October 1985 to the present, data were collected through a creel survey that included subsistence and recreational fishing as well as commercial fishing. This report was prepared by DMWR using information obtained by surveying pelagic fishing activities throughout the year. It does not contain information from tournament catches. This report partially fulfills the national standard requirement for a Stock Assessment and Fishery Evaluation (SAFE) report.

Summary

During 1994, most indicators showed dramatic increases in landings and effort. However, it appears that these increases are somewhat illusory and are in large part due to chronic underestimation of participation in the fishery during past years. Improved supervision of data collectors during 1994 resulted in substantially larger estimates of daily participation on creel survey days, which caused a corresponding increase in estimated landings. The 1994 estimates of catch and effort are more accurate than those from the past. Thus, caution must be used when comparing 1994 with past years. The estimated number of trips increased from 536 in 1993 to 1,741 in 1994. Since catch per unit effort (CPUE) was similar to 1993 for all species, landings appeared to increase accordingly--skipjack tuna landings were 5.8 times larger, yellowfin tuna landings were 2.6 times larger, and landings for other species were up similar amounts.

The pelagic fishery in American Samoa began in the early 1970s and continues to operate on a small scale. In 1994, 41 boats made an estimated 1,741 trips where a pelagic fish species was landed. The majority of the boats operated on a part-time basis, and most trips were one day in duration.

In general, American Samoa's pelagic fishery appears to be driven more by economics and the effects of hurricanes than by species abundance and availability. In the early 1980s, the fishery prospered from rising prices, government assistance in the form of low interest loans for boat purchases and an active program to develop gear types and techniques suited to local conditions. Several devastating hurricanes have struck the territory in recent years--Tusi in January 1987, Ofa in February 1990, and Val in December 1991. The effects of these hurricanes are reflected in the

amount of fishing effort expended; notable decreases in effort are seen in 1987 and 1990. Corresponding drops in catch and revenue are also evident.

The pelagic fishery encounters some competition from a supply of frozen fish purchased or bartered from foreign longline vessels moored in Pago Pago Harbor. In some cases, Samoan fishermen act as middlemen in the transactions between longliners and the market. Poor documentation of these transactions makes it difficult to assess the impact of these exchanges on the market for fresh fish that are supplied by local fishermen. Imports of pelagic fish through regular channels are not currently an important source of competition with the local fishery. The market share of imported pelagic species declined from 66% in 1990, to 20% in 1991, to less than 3% in 1994.

Recommendations

1) Continue efforts to monitor the pelagic fisheries of the local fleet in American Samoa.

2) Attempt to quantify the amount of fish being imported from foreign longline vessels and to what extent this supply impacts the local fishery.

3) Include a summary of landings for American Samoa's two canneries by the distant water fleet. This summary should include annual landing volume and value by gear type and vessel flag (country).

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Table 1. American Samoa 1994 estimated total trolling landings for pelagic species.

Species	Pounds
Skipjack Tuna	148,382
Albacore	1,676
Yellowfin Tuna	50,124
Kawakawa	672
Unidentified Tunas	243
Subtotal Tunas	**201,097**
Mahimahi	11,048
Blue Marlin	12,878
Black Marlin	1,345
Wahoo	9,000
Dogtooth Tuna	2,379
Sharks	13,317
Sailfish	1,705
Subtotal other PPMUS	**51,672**
Barracuda	4,696
Rainbow Runner	394
Subtotal Misc.	**5,090**
Total Pelagics	**257,859**

Table 2. American Samoa 1994 commercial landings, value and average price of pelagic species.

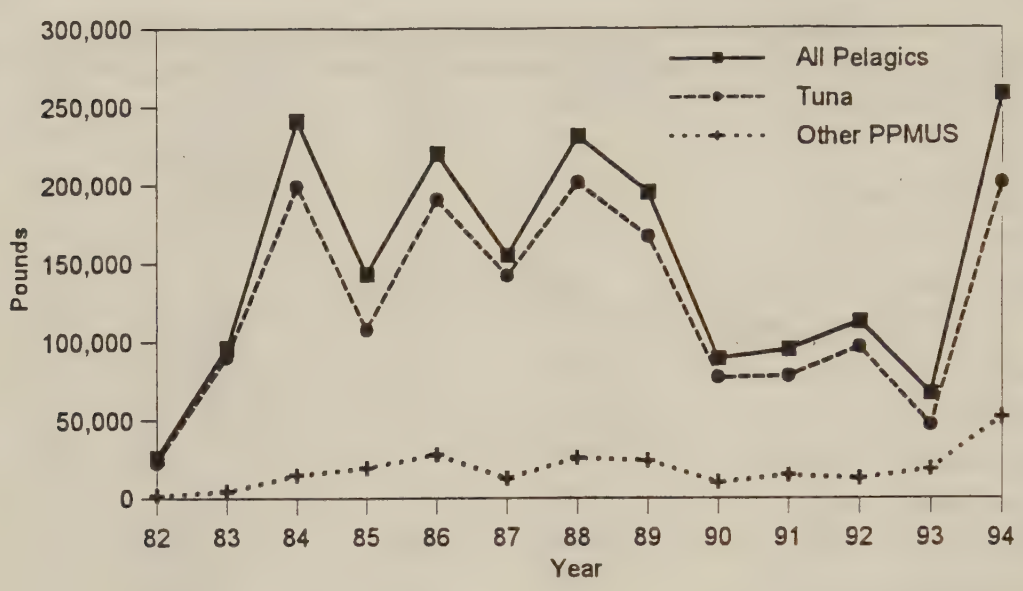
Species	Pounds	$/lb[1]	Value ($)[1]	$/lb[2]	Value ($)[2]
Skipjack Tuna	147,010	1.03	151,420	1.25	183,763
Albacore	1,676	1.00	1,676	1.00	1,676
Yellowfin Tuna	50,079	2.33	116,684	2.25	112,678
Kawakawa	672	1.91	1,284	1.91	1,284
Other Tunas	243	1.00	243	1.00	243
Subtotal Tunas	**199,680**	**1.36**	**271,565**	**1.50**	**299,520**
Sharks	4,536	1.62	7,348	1.65	7,484
Mahimahi	10,955	1.79	19,609	2.19	23,991
Blue Marlin	12,678	1.70	21,553	1.70	21,553
Black Marlin	1,345	1.75	2,354	1.75	2,354
Wahoo	9,000	1.29	11,610	1.79	16,110
Dogtooth Tuna	2,369	1.65	3,909	1.63	3,861
Sailfish	1,705	1.50	2,558	1.54	2,626
Subtotal other PPMUS	**42,588**	**1.62**	**68,993**	**1.84**	**78,362**
Barracudas	4,683	1.62	7,586	1.90	8,898
Rainbow Runner	394	1.61	634	1.53	603
Subtotal Misc.	**5,077**	**1.62**	**8,225**	**1.87**	**9,494**
Total Pelagics	**247,345**	**1.41**	**348,756**	**1.56**	**385,858**

Notes

1. Price and value are calculated based on prices reported by the offshore data collection program where possible. If price data are not available from the offshore program, data from invoices submitted by fish vendors are used in their place. This is the traditional way of calculating price and value.

2. Price and value are calculated from invoices submitted by fish vendors for fish that were taken in American Samoa. Because of improvements in the invoice collection system there are more price data available from this system than from the offshore data collection program. This method is probably a better estimator of average price and value. The two methods were not significantly different (paired t-test, α=0.10).

Figure 1. American Samoa total annual landings: all pelagics, tuna and other PPMUS.

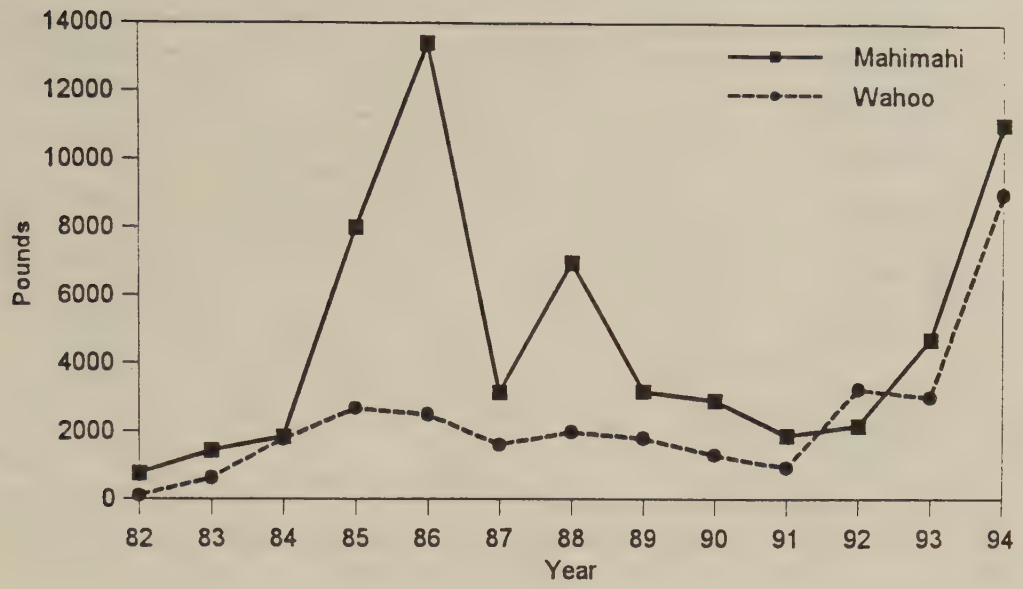


	Pounds Landed		
Year	**All Pelagics**	**Tuna**	**Other PPMUS**
1982	26,396	23,042	2,106
1983	96,318	90,057	4,806
1984	241,099	198,961	15,121
1985	143,212	107,656	19,686
1986	220,063	190,621	28,046
1987	155,324	142,155	12,798
1988	230,951	201,404	25,972
1989	195,563	166,922	24,253
1990	89,240	77,213	10,288
1991	95,009	78,033	15,129
1992	112,431	96,701	13,054
1993	67,037	46,757	18,498
1994	**257,859**	**201,097**	**51,672**

Calculation: Estimated landings for tuna and other PPMUS were calculated by summing the total landings for the species in each category. Estimated landings for all pelagics represent the sum of tuna and other PPMUS plus landings from the miscellaneous category (see Table 1). These figures include both commercial and recreational/subsistence components of the fishery.

Interpretation: Estimated landings increased by almost 400% in 1994. Almost all of this increase appears to be due to chronic underestimation of participation in past years. There was almost no increase in the number of boats participating in the fishery (Fig. 6), catch rates remained similar to those reported for past years and the average trip length remained similar. Though it is possible that the average number of trips made per boat increased, it is more probable that actual landings were fairly similar to last year.

Figure 2. American Samoa annual landings: mahimahi and wahoo.



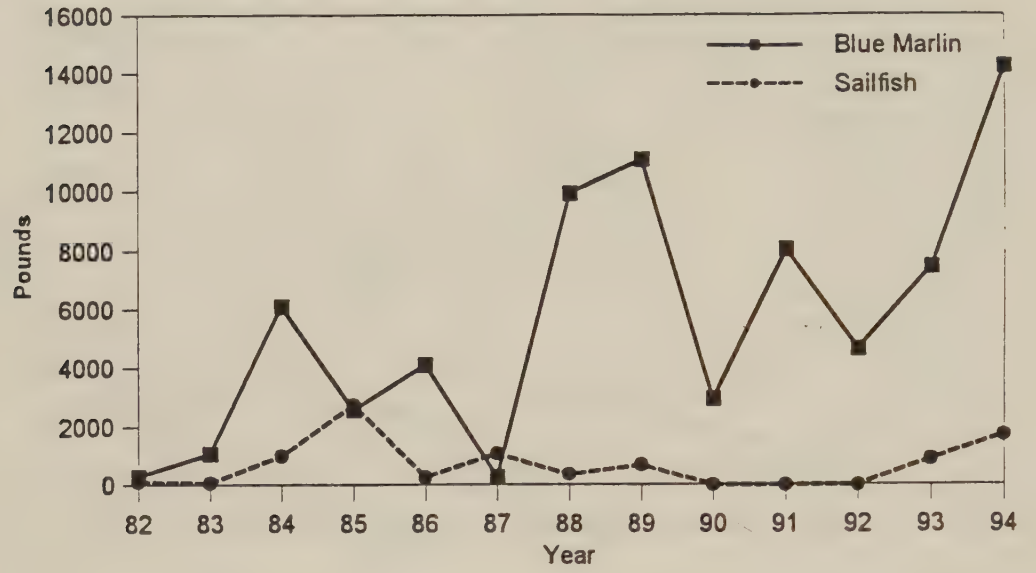
	Pounds Landed	
Year	**Mahimahi**	**Wahoo**
1982	777	114
1983	1,443	632
1984	1,844	1,777
1985	8,011	2,678
1986	13,435	2,492
1987	3,144	1,609
1988	6,976	1,981
1989	3,179	1,804
1990	2,913	1,320
1991	1,890	952
1992	2,174	3,244
1993	4,722	4722
1994	**11,048**	**9,000**

Calculation: The estimated total landings for mahimahi and wahoo are summed for all fishing methods.

Interpretation: Apparent dramatic increases in mahimahi and wahoo landings for 1994 are probably due to improved assessment of fishery participation since CPUE for both species actually declined in 1994 (Fig. 10). Actual landings are probably fairly similar to past years.

Mahimahi landings have been variable across time. Reasons for this variability are unknown, but similar fluctuations appear to occur in other parts of the western Pacific region. From 1984 to 1988, when American Samoan fishermen exported mahimahi to Hawaii, landings were unusually high. 1994 landings are the largest since that time. Wahoo landings have been more stable across time and have generally contributed less to the total catch.

Figure 3. American Samoa total annual landings: blue marlin and sailfish.



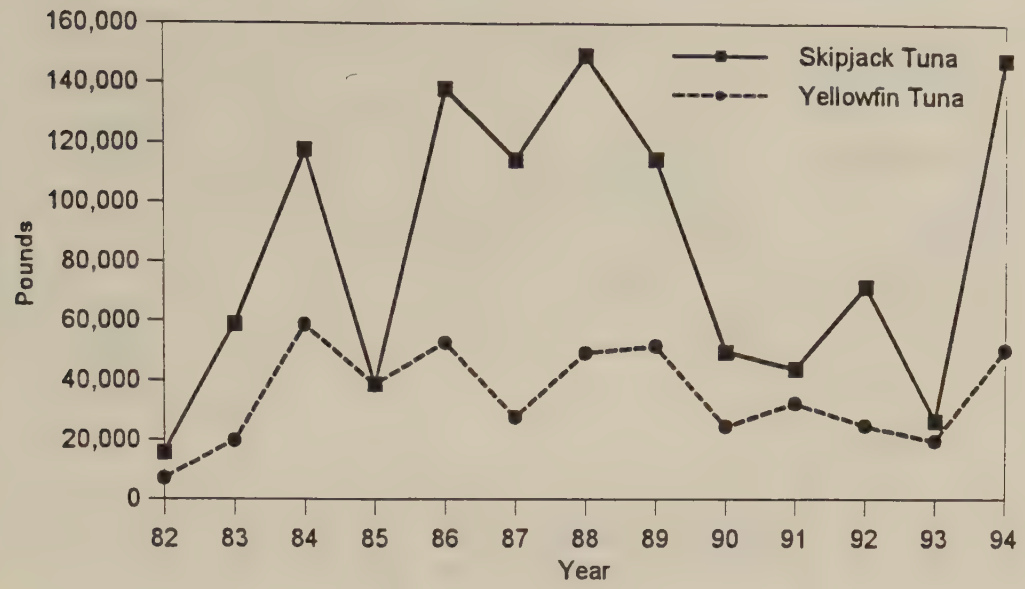
	Pounds Landed	
Year	**Blue Marlin**	**Sailfish**
1982	315	127
1983	1,083	74
1984	6,097	989
1985	2,574	2,744
1986	4,108	271
1987	297	1,081
1988	9,892	367
1989	11,047	687
1990	2,946	0
1991	8,012	0
1992	4,628	0
1993	7,404	873
1994	**14,223**	**1,705**

Calculation: The estimated total yearly landings of blue marlin and sailfish are summed for all fishing methods.

Interpretation: Apparent dramatic increases in blue marlin and sailfish landings for 1994 are probably due to improved assessment of fishery participation. Actual landings are probably fairly similar to past years.

Historic high variability in landings for these species is probably due to the small number of individuals landed. Local commercial fishermen rarely target these species because of the difficulty of capturing and storing such large fish. They are also difficult to process and market.

Figure 4. American Samoa total annual landings: skipjack and yellowfin tuna.

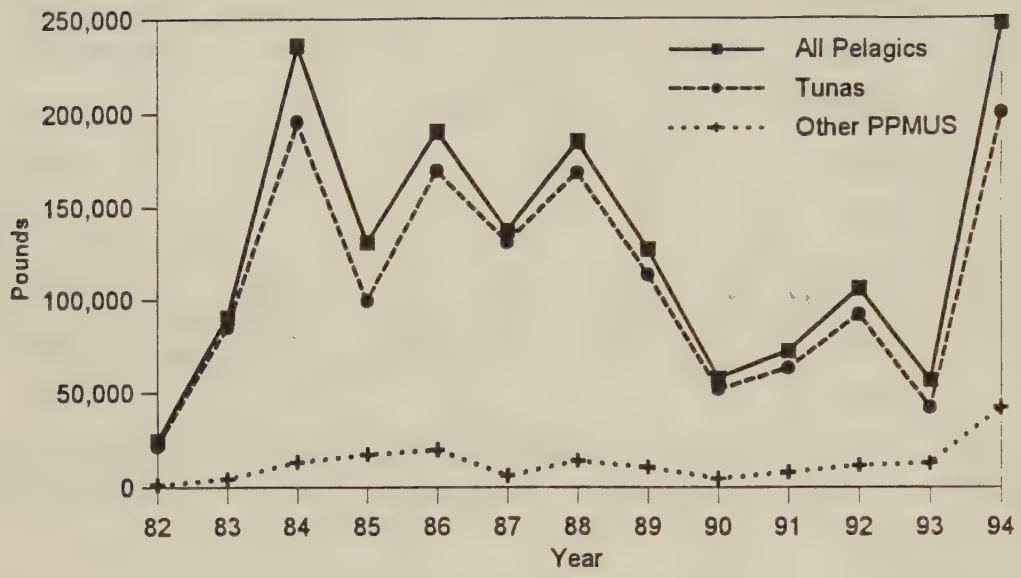


	Pounds Landed	
Year	Skipjack Tuna	Yellowfin Tuna
1982	15,877	7,038
1983	58,997	19,789
1984	117,693	58,704
1985	38,902	38,586
1986	138,064	52,464
1987	114,381	27,627
1988	149,416	49,153
1989	114,805	51,383
1990	49,613	24,565
1991	43,888	32,225
1992	71,677	24,722
1993	26,616	19,775
1994	**148,382**	**50,124**

Calculation: The estimated yearly total landings of skipjack and yellowfin tuna are summed for all fishing methods.

Interpretation: Apparent increases in yellowfin landings are probably due to improved assessment of fishery participation since CPUE declined slightly in 1994 (Fig. 11). Actual landings are probably fairly similar to last year. Dramatically increased skipjack landings are due both to improved assessment of participation and increased CPUE. Skipjack and yellowfin tuna are the two main contributors to total pelagic landings.

Figure 5. American Samoa annual commercial landings: all pelagic species, tunas and other PPMUS.

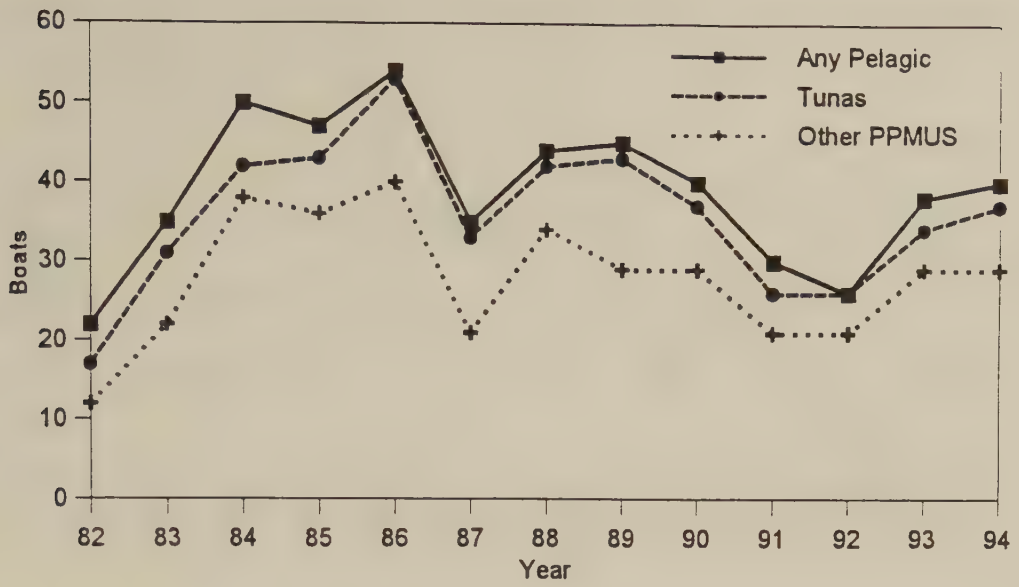


	Pounds Landed		
Year	All Pelagics	Tunas	Other PPMUS
1982	24,820	22,065	1,515
1983	90,744	85,069	4,441
1984	236,216	196,100	13,458
1985	131,310	99,987	17,515
1986	190,998	169,986	19,949
1987	137,925	131,457	6,305
1988	185,432	168,826	14,210
1989	127,560	113,904	10,745
1990	58,089	52,111	4,903
1991	73,044	63,607	8,096
1992	106,299	92,381	11,759
1993	57,184	42,573	12,945
1994	**247,347**	**199,681**	**42,589**

Calculation: Estimated commercial landings for tunas and other PPMUS were calculated by summing commercial landings for the species in each category. Estimated landings for all pelagics represent the sum of tunas and other PPMUS plus landings for the miscellaneous category (see Table 1).

Interpretation: Commercial landings represent the vast majority of landings for pelagic species; thus Fig. 1 and Fig. 5 are virtually identical. Estimated landings appeared to be over four times larger in 1994. Almost all of this increase is probably due to chronic underestimation of participation in past years.

Figure 6. Number of American Samoa boats landing any pelagic species, tunas and other PPMUS.

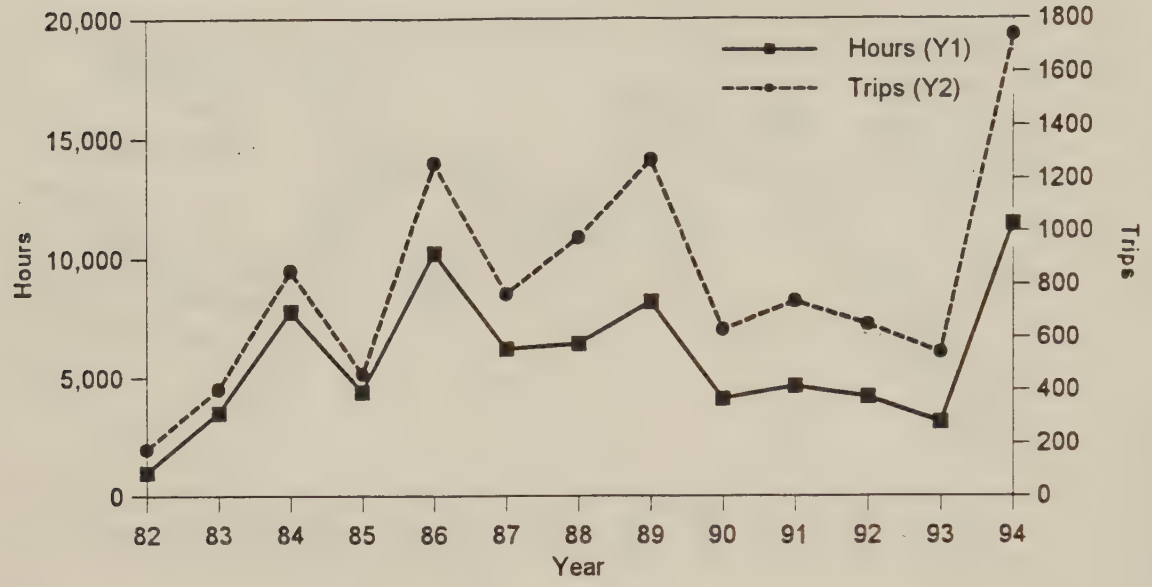


	Number of Boats landing:		
Year	**Any Pelagic**	**Tunas**	**Other PPMUS**
1982	22	17	12
1983	35	31	22
1984	50	42	38
1985	47	43	36
1986	54	53	40
1987	35	33	21
1988	44	42	34
1989	45	43	29
1990	40	37	29
1991	30	26	21
1992	26	26	21
1993	38	34	29
1994	**40**	**37**	**29**

Calculation: The sampling program is extensive enough, and the number of boats small enough, to use the raw database counts of the number of unique vessels in a given year. When data are collected, the vessel is always identified. Each boat counted in the above table made at least one recorded landing of at least one pelagic species during a given year.

Interpretation: In spite of major apparent increases in landings and participation due to improved assessment of fishery participation, there was no increase in the total number of boats participating in the fishery. As in past years, a small number of "highliners" dominate the pelagic fishery, with 29% of the boats being responsible for landing 80% of the pelagic catch.

Figure 7. American Samoa fishing effort for pelagic species (trolling only).

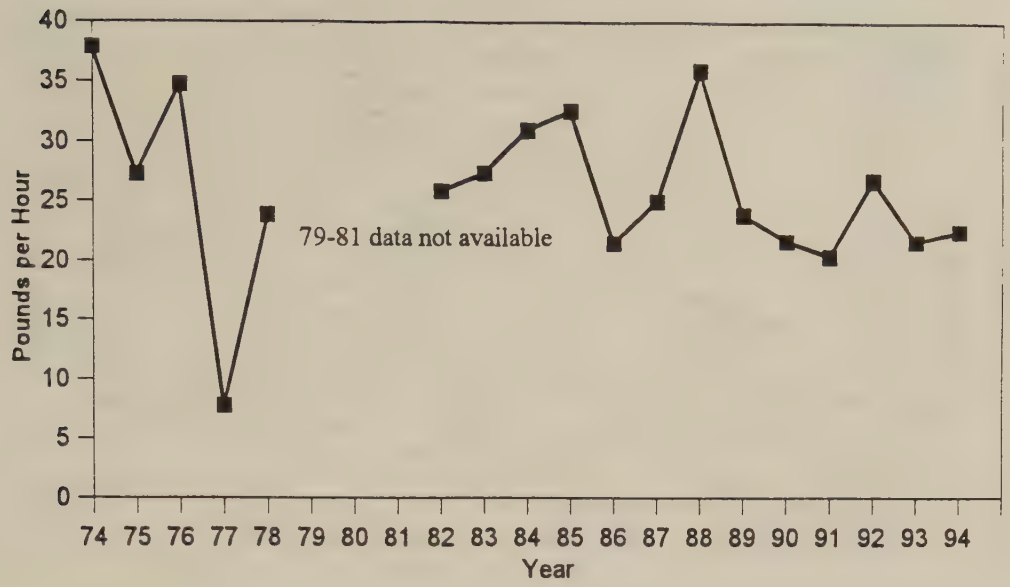


	Estimated Trolling Effort				
Year	Hours	Trips	Year	Hours	Trips
1982	1,019	177	1989	8,177	1,273
1983	3,513	406	1990	4,103	631
1984	7,785	853	1991	4,656	739
1985	4,394	464	1992	4,178	650
1986	10,240	1,259	1993	3,103	545
1987	6,218	764	**1994**	**11,453**	**1,738**
1988	6,421	978			

Calculation: Estimated total annual landings are used as a base for estimating trolling effort. The estimated total longlining landings are subtracted from the total landings, and the resultant number is divided by the average trolling catch per hour (CPUE) to give an estimate of the hours trolled. Trolling CPUE is calculated using only those trips where trolling was the only method used, and for which the number of hours was recorded. The number of trips is calculated by dividing the estimated total hours of effort by the average length of a trolling trip.

Interpretation: Fishing effort appeared to almost triple in 1994. This increase is probably largely illusory and is due to underestimation of participation in past years. Since the number of boats participating in the pelagic fishery has remained virtually unchanged since 1993 (Fig. 6), the only other explanation for large increases in effort is that the same boats are being used much more intensively. According to unexpanded creel survey data, five fishermen were responsible for 77% of the pelagic landings for Tutuila Island in 1994, these same fishermen were responsible for 64% of the landings in 1993. In 1994, this group of fishermen appeared to have landed over three times as much fish as in 1993. These five fishermen were individually interviewed and all felt that they had expanded slightly more effort in 1994 than in 1993 but none felt that they had fished twice as much. It is probable that individual boats are being used more intensively, but that this only explains a small part of the increased effort.

Figure 8. American Samoa overall pelagic catch per hour trolling.

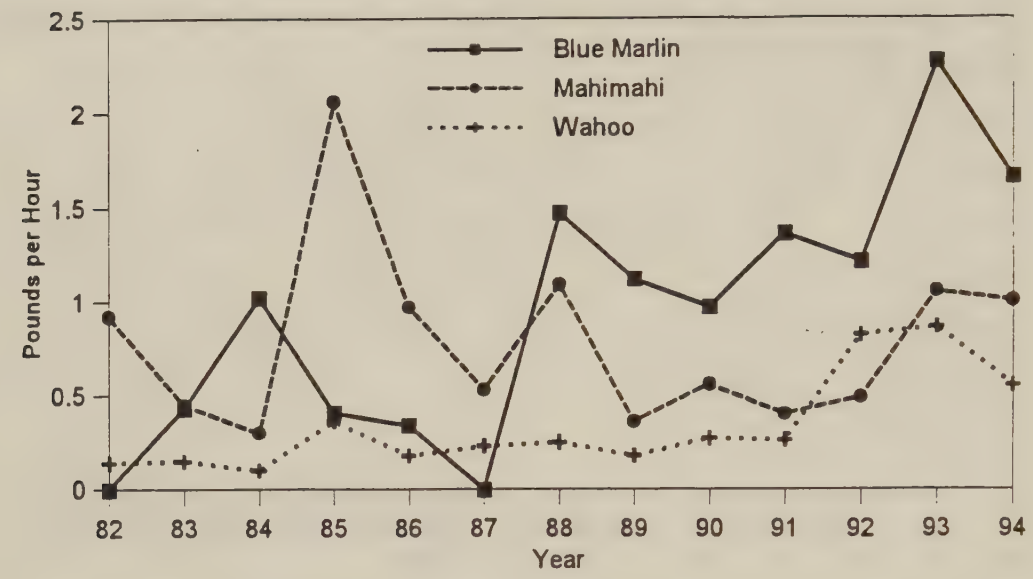


Year	Lb/Hr	Trips	Year	Lb/Hr	Trips
1974	37.9	31	1986	21.5	401
1975	27.3	98	1987	25.0	217
1976	34.8	10	1988	36.0	284
1977	7.8	6	1989	23.9	373
1978	23.9	96	1990	21.7	287
1982	25.9	104	1991	20.4	211
1983	27.4	156	1992	26.8	204
1984	31.0	311	1993	21.6	220
1985	32.6	193	**1994**	**22.5**	**388**

Calculation: For trips where trolling was used exclusively, and where effort was recorded, the total catch was divided by the total number of trolling hours to obtain CPUE. Data are from three sources; 1974-78 are from the Dory Project, 1982-84 are from the commercial catch monitoring system, and 1985-94 are from the creel survey program.

Interpretation: Total pelagic species CPUE is predominantly the combined skipjack and yellowfin CPUE shown in Fig. 11, as these two species contribute close to 85% of the total catch. Pelagic species CPUE has been variable, especially in the early years of the American Samoa troll fishery. Low CPUE in 1977 was possibly due to small sample sizes and other data collection problems. Reduced 1990, 1991 and 1992 CPUE was possibly due to the loss of all but one of the Fish aggregation devices (FADs) surrounding Tutuila, shortly after Hurricane Ofa in February 1990. 1994 CPUE was slightly higher than 1993 due to increased CPUE for skipjack tuna.

Figure 9. American Samoa trolling catch rates: blue marlin, mahimahi and wahoo.

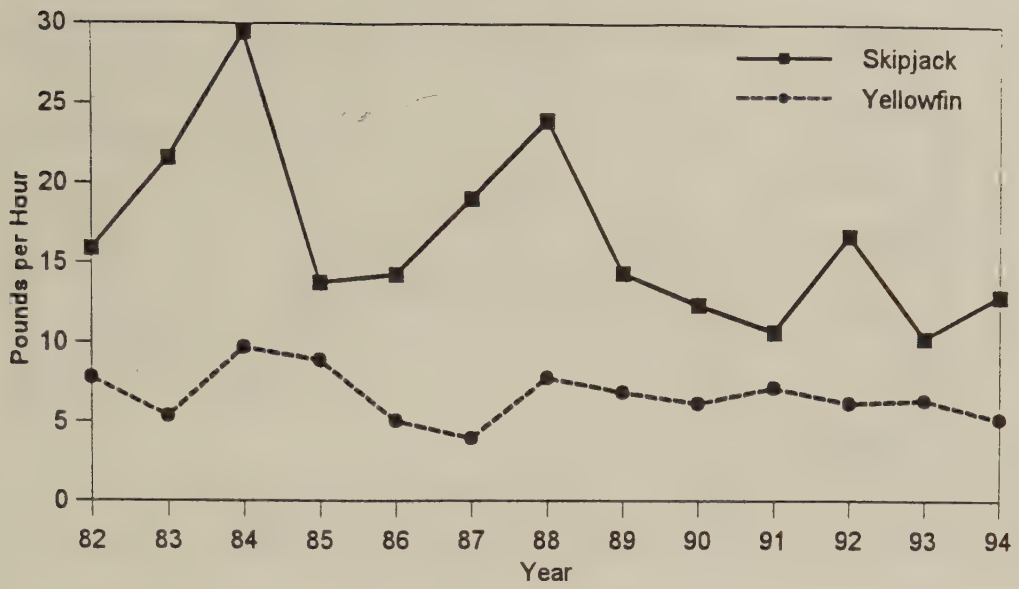


	Pounds Caught per Hour Trolling		
Year	**Blue Marlin**	**Mahimahi**	**Wahoo**
1982	0.00	0.92	0.14
1983	0.43	0.45	0.15
1984	1.02	0.30	0.10
1985	0.41	2.06	0.36
1986	0.34	0.97	0.18
1987	0.00	0.53	0.23
1988	1.47	1.09	0.25
1989	1.12	0.36	0.18
1990	0.97	0.56	0.27
1991	1.36	0.40	0.26
1992	1.21	0.49	0.82
1993	2.27	1.05	0.86
1994	**1.66**	**1.00**	**0.55**

Calculation: For trips where trolling was used exclusively, and where effort was recorded, the total catch by species was divided by the total number of trolling hours to obtain CPUE.

Interpretation: Blue marlin CPUE is highly variable but has shown a gradual increase across time. The high variability is probably due to small number of individual fish taken, while the overall increase in CPUE is probably due to gear and boat improvements that have allowed fishermen to successfully harvest these large fish. Mahimahi CPUE peaked in the mid eighties, when an export market existed for this species. Since that time, mahimahi CPUE has been variable, but without obvious trend. Wahoo CPUE increased substantially in 1993 and remained high in 1994.

Figure 10. American Samoa trolling catch rates: skipjack and yellowfin tuna.

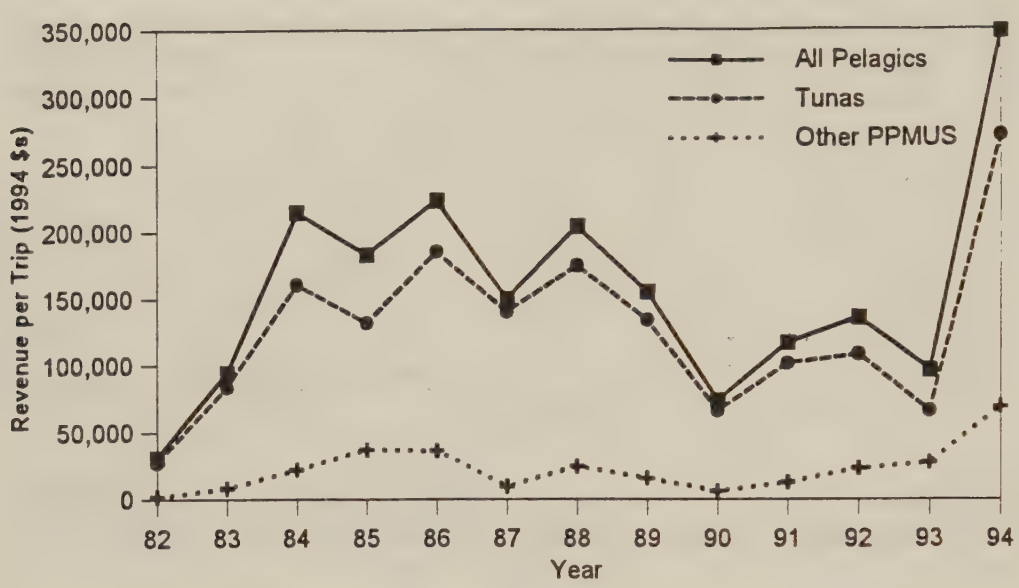


	Pounds Caught Per Hour Trolling	
Year	**Skipjack**	**Yellowfin**
1982	15.9	7.8
1983	21.6	5.4
1984	29.5	9.7
1985	13.8	8.9
1986	14.3	5.1
1987	19.1	4.0
1988	24.0	7.8
1989	14.4	6.9
1990	12.4	6.2
1991	10.7	7.2
1992	16.8	6.2
1993	10.3	6.4
1994	**13.0**	**5.2**

Calculation: For trips where trolling was used exclusively, and where effort was recorded, the total catch by species was divided by the total number of trolling hours to obtain CPUE.

Interpretation: Both skipjack and yellowfin CPUE have been highly variable through the years. In spite of this variability, a declining trend is apparent in CPUE for both species, especially skipjack tuna.

Figure 11. American Samoa annual inflation-adjusted revenue for commercially landed pelagic species.

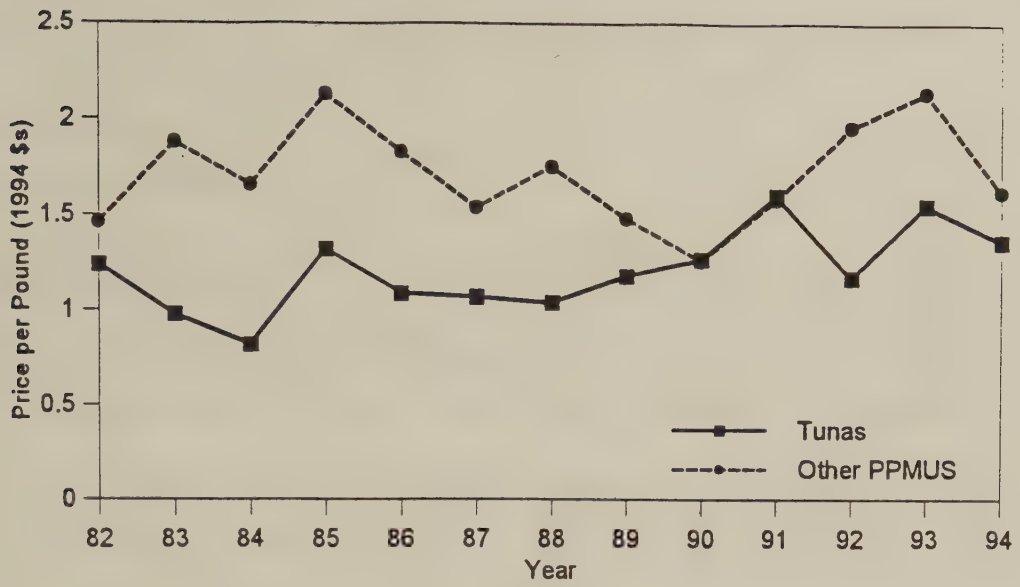


	Revenue ($)					
	All Pelagics		Tunas		Other PPMUS	
Year	Unadjust.	Adjusted	Unadjust.	Adjusted	Unadjust.	Adjusted
1982	21,824	31,427	18,990	27,346	1,534	2,209
1983	66,254	94,743	58,561	83,742	5,828	8,334
1984	153,571	214,999	114,981	160,973	15,938	22,313
1985	131,961	183,426	95,157	132,268	26,800	37,252
1986	166,851	223,580	138,498	185,587	27,311	36,597
1987	116,564	150,368	108,816	140,372	7,527	9,710
1988	163,189	203,986	139,902	174,877	19,940	24,924
1989	129,460	155,352	111,923	134,308	13,269	15,923
1990	66,865	74,220	59,747	66,319	5,554	6,165
1991	110,275	116,892	95,936	101,692	12,083	12,808
1992	132,899	135,557	106,260	108,385	22,629	23,081
1993	94,707	96,601	64,890	66,188	27,113	27,655
1994	**348,401**	**348,401**	**271,170**	**271,170**	**68,993**	**68,993**

Calculation: Revenues from commercial landings for all pelagic species are adjusted for inflation by multiplying a given year's revenue by the quotient of the 1993 consumer price index (CPI) divided by the CPI for that year.

Interpretation: Sharp increases in revenue from pelagic landings are due to chronic underestimation of landings in past years. It does not appear to be due to actual increased landings since fishermen actually received less per pound for tunas and other PPMUS in 1994 than in 1993 (Fig. 9).

Figure 12. American Samoa average price for tunas and other PPMUS.

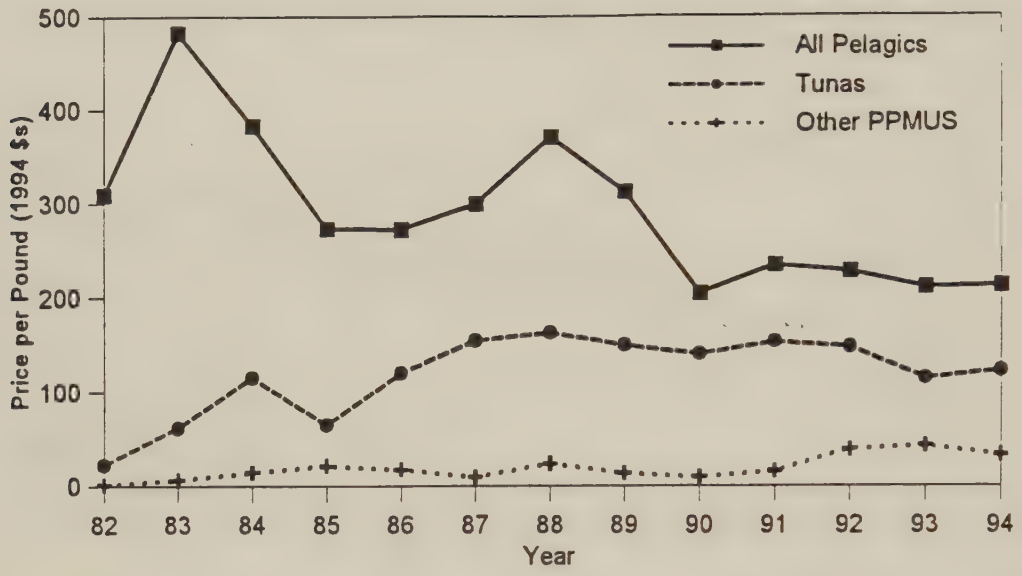


	Average Price ($/lb)			
	Tunas		Other PPMUS	
Year	Unadjust.	Adjusted	Unadjust.	Adjusted
1982	0.86	1.24	1.01	1.46
1983	0.69	0.98	1.31	1.88
1984	0.59	0.82	1.18	1.66
1985	0.95	1.32	1.53	2.13
1986	0.81	1.09	1.37	1.83
1987	0.83	1.07	1.19	1.54
1988	0.83	1.04	1.40	1.75
1989	0.98	1.18	1.23	1.48
1990	1.15	1.27	1.13	1.26
1991	1.51	1.60	1.49	1.58
1992	1.15	1.17	1.92	1.96
1993	1.52	1.55	2.09	2.14
1994	**1.36**	**1.36**	**1.62**	**1.62**

Calculation: The average price per pound for each year is calculated by dividing the estimated revenue by the estimated weight sold. The adjustment for inflation is made by multiplying the annual average price for a given year by the 1993 consumer price index (CPI) for American Samoa, and dividing by the CPI for the given year.

Interpretation: Prices for both tuna and other PPMUS declined in 1994. In spite of this, the long-term trend remains toward gradually increased prices for pelagic species.

Figure 13. American Samoa average inflation-adjusted per trip revenue for trips landing PPMUS.



	Revenue per trip ($)					
	All Pelagics		Tunas		Other PPMUS	
Year	Unadjust.	Adjusted	Unadjust.	Adjusted	Unadjust.	Adjusted
1982	214	309	16	23	1	2
1983	338	483	43	62	5	7
1984	274	383	82	115	11	15
1985	196	273	47	65	16	22
1986	203	272	90	120	14	18
1987	232	299	119	154	8	10
1988	297	371	130	162	19	24
1989	260	312	124	149	12	14
1990	184	204	126	140	9	10
1991	221	234	145	153	15	16
1992	223	227	144	147	38	39
1993	206	210	111	114	42	43
1994	**212**	**212**	**122**	**122**	**33**	**33**

Calculation: For commercial trips where pelagic species were landed, the average revenue per trip was calculated for each category. Revenue was adjusted for inflation by multiplying it by the quotient of the 1994 CPI divided by the CPI for the year.

Interpretation: Revenues per trip remained essentially constant in 1994. Slight increases in tuna revenues were due to higher skipjack tuna CPUE (Fig. 11) which counteracted lower ex-vessel tuna prices.

Appendix 2

Territory of Guam

Introduction and Summary

Pelagic fishing vessels based on Guam fall into two broad categories: 1) distant -water purse seiners and longliners that fish primarily outside the EEZ and transship through Guam and 2) small primarily recreational trolling boats that are either towed to launch sites or berthed in the Marinas and fish only local waters, either within the EEZ or occasionally in the adjacent EEZ of the Northern Mariana Islands. This report covers primarily the local small-boat pelagics fishery.

During the past 15 years, the estimated number of vessels participating in the fishery has steadily increased from about 119 to 328. Presently most vessels are under 10 m (33 ft) in length and are typically owner-operated by persons who earn a living outside of fishing. However, almost everyone sells a portion of their catch at one time or another, and it is impossible to make a distinction between recreational, subsistence, or commercial fishers. A small but rapidly growing segment of the fleet consist of marina-berthed charter vessels that are operated primarily by full-time captains and crews.

Estimated annual landings have varied widely, ranging between 175 and 429 tons. Landings consist nearly entirely of five major species: mahimahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), and Pacific blue marlin (*Makaira mazara*). Minor components include rainbow runner (*Elagatis bipinnulatus*), great barracuda (*Sphyraena barracuda*), kawakawa (*Euthynnus affinis*), dogtooth tuna (*Gymnosarda unicolor*), sailfish (*Istiophorus platypterus*), and shortbill spearfish (*Tetrapterus angustirostris*). Approximately a dozen additional species are landed incidentally each year.

There are wide year to year fluctuations in the catches of mahimahi, wahoo, and tunas. However, annual landings of yellowfin tuna appear to have declined from 1982 to 1989, recovered in 1992, but declined during the past two years. Annual landings of blue marlin increased sharply from 1980 to 1990, declined somewhat during 1993, and recovered during 1994.

Aggregate landings of non-tuna PPMUS appear to be increasing while those of tunas show no general trend. In the early 1980s the bulk of the catch consisted of tunas, but since 1985 it has consisted of non-tuna, or "other", PPMUS, with mahimahi usually the most important species. Commercial landings of all pelagics has increased steadily over the past 14 years with all of the increase in the non-tuna PPMUS segment.

Effort in terms of hours and trips has increased since 1983, while hours spent per trip has decreased. This is a reflection of the growing charter segment of the fishery which generally makes half-day rather than full-day trips.

Inflation adjusted revenues for all pelagic species, tunas and other PPMUS have decreased slightly from peaks during 1983-84, while inflation adjusted revenue per trip for all pelagic species, tunas and other PPMUS has sharply decreased over the past 11 years.

Annual trolling catch rates have varied widely for all species. However, there seems to have been a general increase in the catch rate of blue marlin from 1980 to 1990, and a decrease since in the catch rate of yellowfin tuna from 1982 to 1989. The average size and size of the winning fish for yellowfin tuna caught in the Guam International Fishing Derby also decreased from 1978 to 1989, and from 1979 to 1989, respectively, but has fluctuated widely since then. The period of increase in the catch rate of blue marlin was probably due to a concurrent increase in the charterboat segment which operates larger vessels more capable of targeting this species. Decreases in the catch rates and size of yellowfin tuna may be a result of either adverse impacts on their regional stocks by other (e.g., longline or purse seine) fisheries, or decreasing availability due to interception near Guam by these other fisheries.

Inflation-adjusted prices have steadily declined since 1980. The difficulty of obtaining a consistent supply of fresh fish from local fishermen has forced many marketers to turn to other sources, at least part of the time. Some hotels import higher-priced tuna from Japan to meet their demand for sashimi. There is a widespread belief among local fishermen that the flooding of local markets with inexpensive foreign-caught fish in recent years has depressed their ex-vessel prices. There is also evidence that a considerable quantity of low-cost "grade B" yellowfin tuna, destined for surface transshipment enters the local economy illegally.

There was one domestic longliner and no foreign longliners licenced to fish within Guam's EEZ during 1994. However, the Guam Department of Commerce reported that during 1994 one domestic longliner and 348 foreign longliners made 1,509 port calls and transshipped 12,283 t of fishes through Guam. This included 6,554 t of yellowfin tuna (53%), 4,896 t of bigeye tuna (40%), 472 t of blue marlin (4%), and 361 t of albacore, striped marlin, swordfish, and others (3%). With the possible exception of 8 t caught by a domestic longliner, all of this was allegedly caught outside of Guam's EEZ. The extent of illegal longlining activity is unknown.

Recommendations

1) A comparison of expansion estimates for Oct-Dec 1994 derived by existing algorithms of the Guam Offshore Expansion System (GOES) and those based on newly derived algorithms in combination with additional data from the Agat Marina and Merizo Pier reveal several differences. These differences ranged from ±4 to ±20% for most parameters, but were 25-43% higher for the new method for various measures of CPUE and are attributable to inherent biases in the existing method. Since both methods were run on a spreadsheet rather than a database, no statistics are available to gauge the significance of these differences. Preparation of a new expansion system using the

database 4th Dimension will be contracted out in May 1995 and should be on line by August. Data for 1991-94 should be entered in the new database, re-expanded with associated statistics, and replace existing data in forthcoming annual reports. Older data going back to 1980 should be edited in order to accommodate new fields and re-expanded at least to the extent of separating the charter and non-charter segments of the fishery.

2) Future reports should include a discussion of the impacts of the Guam-based distant-water fleets on the local fisheries market. Particular attention should be given to assessing and quantifying the leakage of fish caught by these fleets into the local economy and any resulting new industry.

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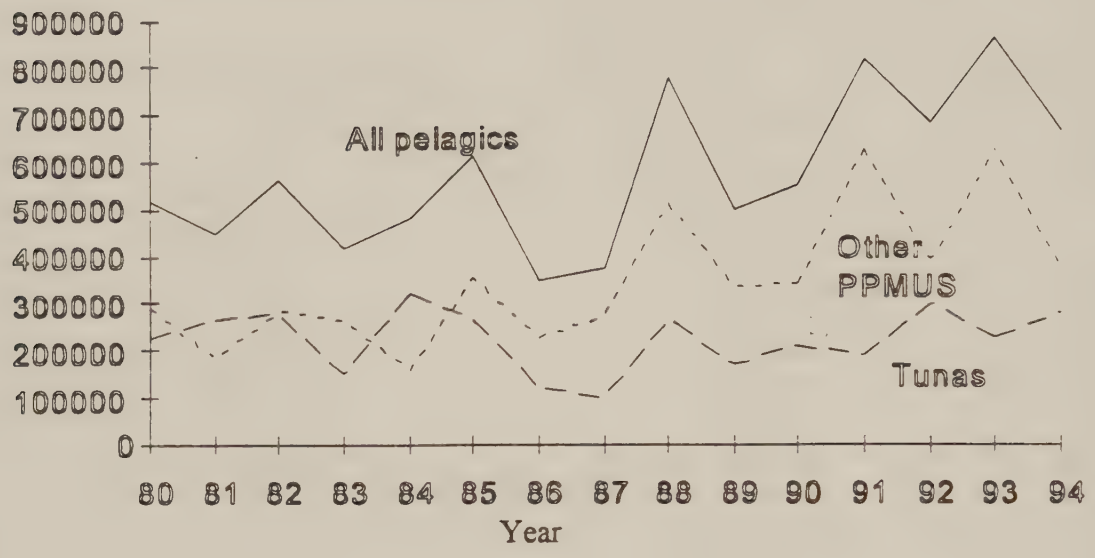
Table 1. Guam 1994 creel survey - pelagic species composition.

Species	Pounds Landed
Sharks	5,093
Mahimahi	175,183
Wahoo	64,595
Blue marlin	121,844
Striped marlin	0
Sailfish	4,482
Spearfish	336
Dogtooth tuna	1,007
Double-lined mackerel	0
Subtotal Non-Tuna PPMUS	**372,541**
Skipjack tuna	207,713
Yellowfin tuna	70,902
Bigeye tuna	0
Kawakawa	1,033
Tunas (misc)	9
Subtotal Tunas	**279,657**
Rainbow runner	5,155
Barracudas	6,124
Subtotal Misc.	**11,278**
Total Pelagics	**663,476**

Table 2. Guam 1994 annual commercial average price of pelagic species.

Species	Average Price ($/lb)
Sharks	0.50
Mahimahi	1.70
Wahoo	2.16
Marlin	1.06
Spearfish	1.58
Sailfish	1.34
Dogtooth tuna	1.94
Average Non-Tuna PPMUS	**1.67**
Skipjack tuna	0.97
Yellowfin tuna	2.43
Kawakawa	1.21
Average Tunas	**1.73**
Troll fish	1.71
Rainbow runner	1.97
Barracuda	1.63
Average All Pelagics	**1.69**

Figure 1. Guam annual estimated total landings: all pelagics, other PPMUS, and tunas.



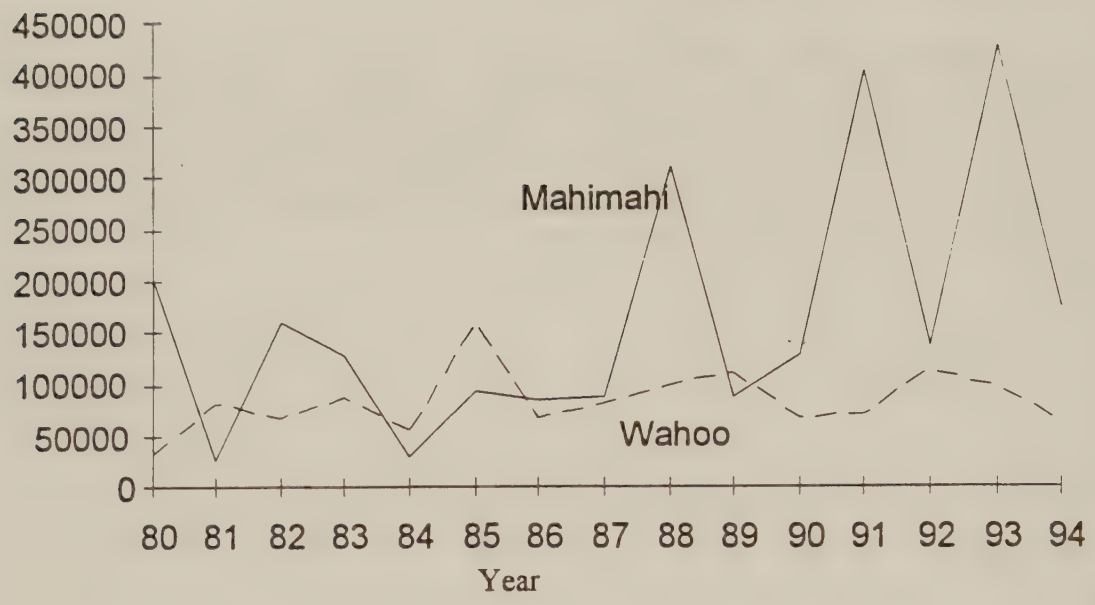
Year	Pounds Landed		
	All Pelagics	Other PPMUS	Tunas
1980	515,631	290,703	224,928
1981	450,813	183,549	267,264
1982	560,046	284,195	275,851
1983	418,222	267,117	151,106
1984	479,134	321,143	157,991
1985	614,520	352,649	261,872
1986	347,673	227,130	120,543
1987	370,586	268,068	102,519
1988	776,336	510,551	265,785
1989	501,880	334,857	167,024
1990	549,944	341,785	208,159
1991	814,786	627,398	187,388
1992	685,513	388,634	296,833
1993	858,944	626,907	224,656
1994	**663,476**	**372,541**	**279,657**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. The Guam Offshore Expansion System (GOES) and its algorithms are detailed in NMFS Admin. rep. H-83-21C. For 1992-94, the GOES was not available and expansions were calculated on a commercially available spreadsheet with Macintosh computers. Details available from DAWR on request. A 362-day (363 days during leap years) expansion is run for each calendar year of survey data and is added to the results of the 3-day Guam International Fishing Derby (GIFD) to produce catch and effort estimates for each fishing method surveyed. Percent species composition is calculated by weight for the sampled catch for each method to produce catch estimates for each species for the expanded period. The annual catch for all pelagic species and the PPMUS

separately are summed across all methods to obtain the numbers plotted above except for 1992 which includes only the trolling method.

Interpretation: Guam's pelagic fishery is growing, particularly the charterboat segment which has more than doubled during the past few years. In the early 1980s, the bulk of the catch tended to consist of tunas, but since 1985 it has consisted of other (non-tuna) PPMUS. Reasons for this include a trend towards decreasing size and availability of yellowfin tuna from 1983 to 1989, lack of interest in skipjack tuna, and an increasing interest in targeting blue marlin. Virtually all landings (>99%) are by the trolling method.

Figure 2. Guam annual estimated total landings: mahimahi and wahoo.

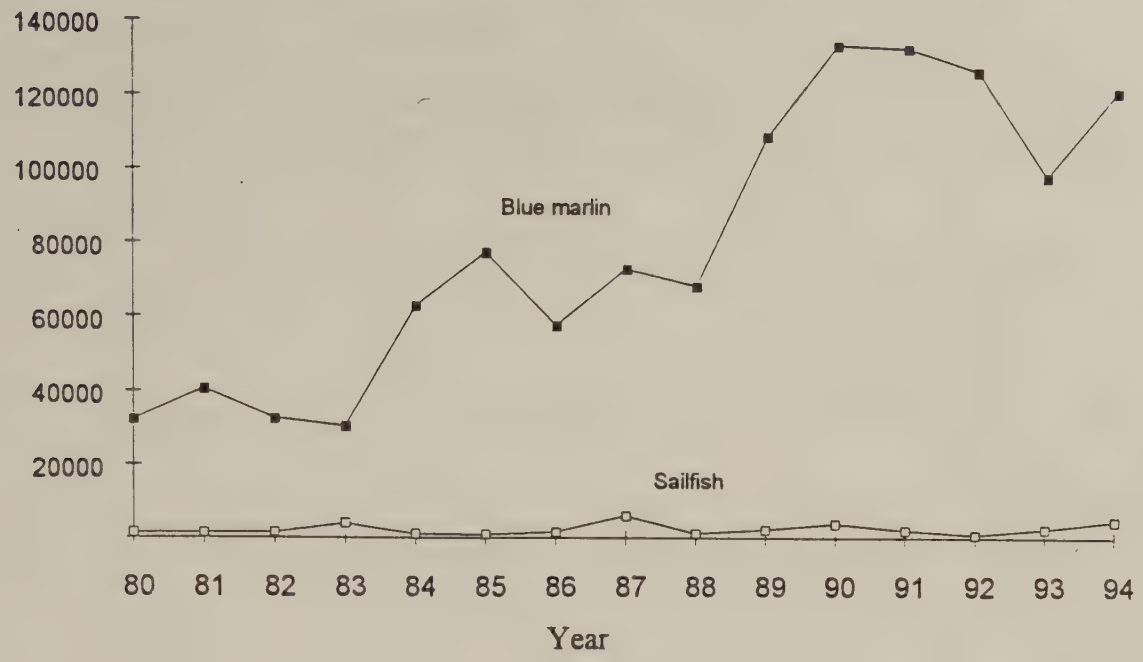


Year	Pounds Landed Mahimahi	Wahoo
1980	203,136	32,825
1981	27,954	82,635
1982	160,200	66,416
1983	128,130	89,010
1984	28,847	56,501
1985	92,407	159,300
1986	85,393	68,830
1987	86,362	82,892
1988	310,032	99,801
1989	87,158	111,977
1990	126,968	66,107
1991	402,107	71,001
1992	136,421	112,872
1993	423,988	97,448
1994	**175,183**	**64,595**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. Totals by species are summed across all fishing methods for all years except 1992-93 as described in Fig. 1.

Interpretation: Landings of mahimahi exceeded those of all other species during eight of the past 15 years, making it the most important species in Guam's small boat fishery. Record high landings of mahimahi in 1993 were followed by relatively poor landings in 1994. This is consistent with a long-term pattern of extreme fluctuations. Wahoo landings have fluctuated widely, but not to the extreme extent exhibited by mahimahi. Wahoo landings have declined during the past two years. Virtually all landings are by the trolling method.

Figure 3. Guam annual estimated total landings: blue marlin and sailfish.



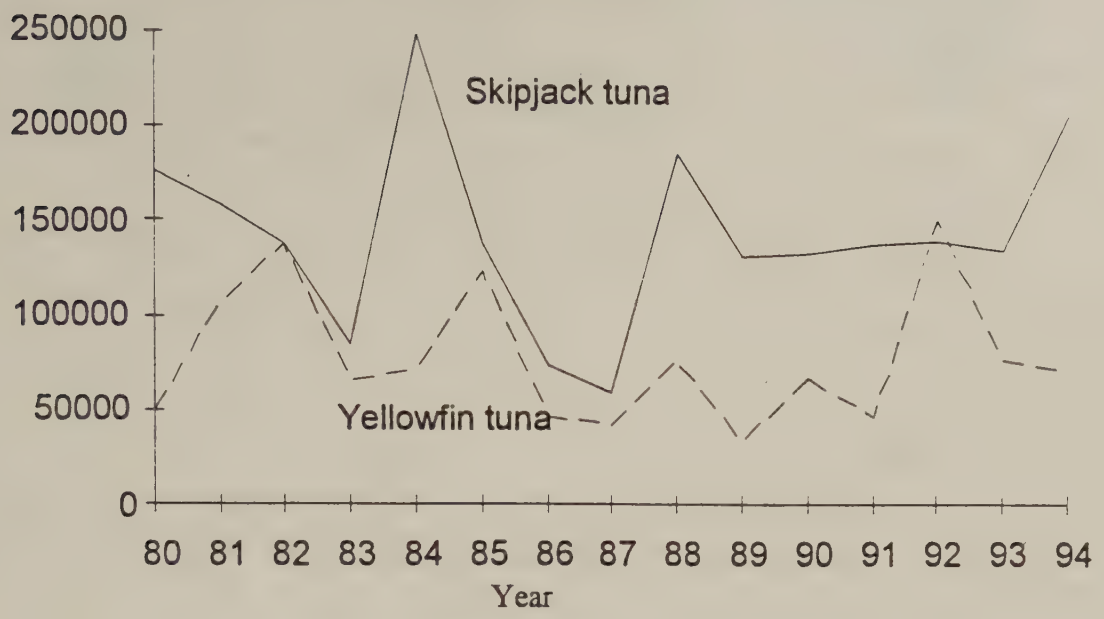
	Pounds Landed	
Year	**Blue Marlin**	**Sailfish**
1980	32,192	1,411
1981	40,389	1,272
1982	32,465	1,425
1983	30,359	3,820
1984	63,057	952
1985	77,565	915
1986	57,682	1,474
1987	73,169	5,913
1988	68,511	1,145
1989	109,241	2,191
1990	136,541	3,730
1991	129,992	2,000
1992	127,356	745
1993	98,698	2,379
1994	**121,844**	**4,482**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. Totals by species are summed across all fishing methods for all years except 1992-93 as described in Fig. 1.

Interpretation: Landings of blue marlin increased steadily between 1980 and 1990, remained high through 1992, decreased in 1993, then returned to near 1990-92 levels during the past year. Growth was particularly rapid between 1988 and 1990. The rapidly growth in the charter fleet is undoubtedly the reason for this rapid growth in landings and the recent decline could be

attributable to a decline in charter activity during the past year. Although statistics are not available, this decline in charter activity was probably a result of a decline in tourism due to a combination of a depressed economy in Japan and recent natural disasters on Guam. In 1990, landings of blue marlin exceeded those of all other species. Some blue marlin were tagged and released during the past three years and that number is expected to grow. Sailfish landings have remained insignificant. Virtually all landings are by the trolling method.

Figure 4. Guam annual estimated total landings: skipjack and yellowfin tunas.

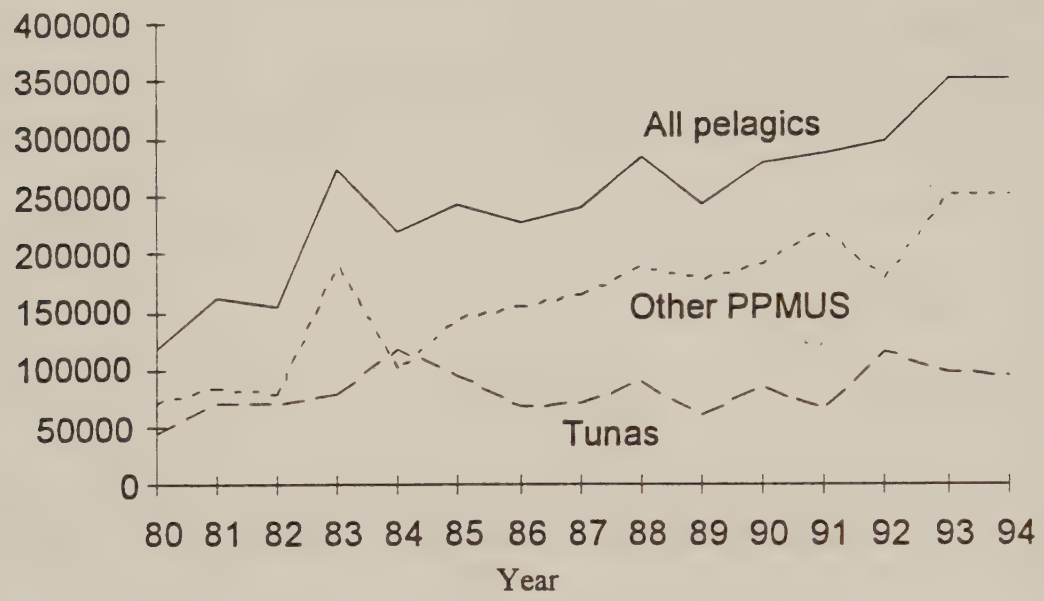


	Pounds Landed	
Year	**Skipjack tuna**	**Yellowfin tuna**
1980	175,542	49,386
1981	158,493	107,828
1982	137,735	137,202
1983	85,008	65,598
1984	248,243	71,502
1985	137,097	122,707
1986	73,199	47,290
1987	59,228	41,754
1988	184,838	77,434
1989	130,682	34,404
1990	133,460	68,076
1991	137,136	47,398
1992	138,547	151,025
1993	135,163	76,285
1994	**207,713**	**70,902**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. Totals by species are summed across all fishing methods for all years except 1992-93 as described in Fig. 1.

Interpretation: Landings of skipjack tuna exceeded those of all other species in five of the last 15 years, and were exceeded by mahimahi in all but one of the remaining years. With the exception of 1992, landings of skipjack tuna have always exceeded those of yellowfin tuna, often by a 2:1 or better margin. Given the relatively low market demand of skipjack tuna in the local market, and the desirability of yellowfin tuna, the availability of skipjack tuna probably exceeds that of yellowfin tuna by a wider margin than this chart would indicate. Virtually all landings are by the trolling method.

Figure 5. Guam annual estimated commercial landings: all pelagics, tunas, and other PPMUS.

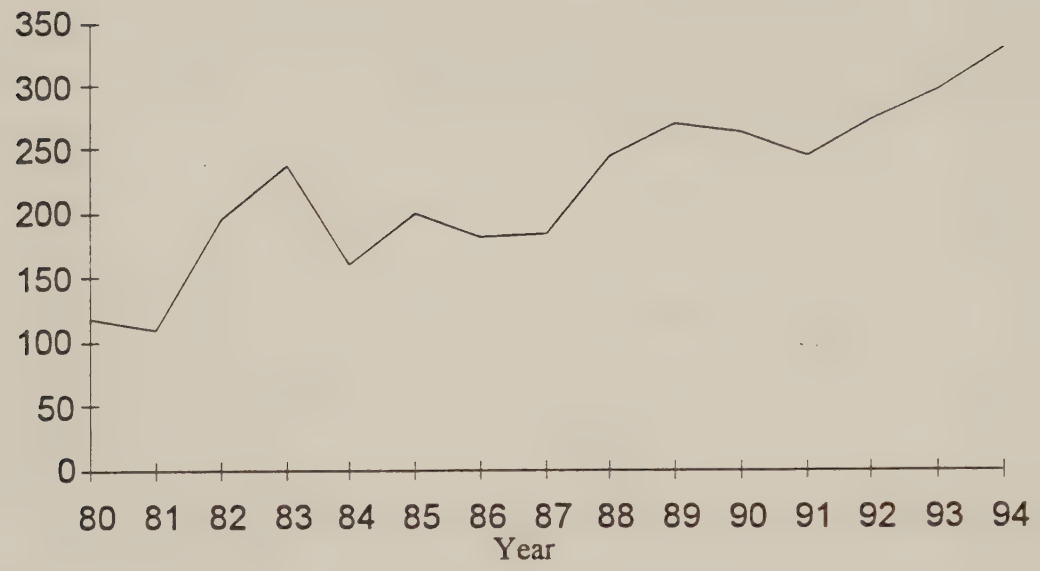


		Pounds Landed	
Year	**All Pelagic Species**	**Tunas**	**Other PPMUS**
1980	118,275	45,043	70,319
1981	162,186	72,229	84,371
1982	153,577	72,347	77,602
1983	273,120	79,313	189,241
1984	220,074	118,167	98,412
1985	243,060	94,691	143,509
1986	227,928	68,510	154,749
1987	240,790	71,711	163,449
1988	283,264	87,962	188,498
1989	242,554	59,825	178,424
1990	279,121	84,176	190,201
1991	285,696	64,694	218,588
1992	296,809	114,765	178,307
1993	351,201	96,289	250,211
1994	**351,187**	**95,321**	**250,348**

Source and Calculation: The WPacFIN-sponsored commercial landings system. The total estimated commercial landings for each year were calculated by summing the weight fields in the commercial landings database from the principle fish wholesalers on Guam, and then multiplying by an estimated percent coverage expansion factor. The annual expansion factor was subjectively created based on as much information as possible depending on the year, including: an analysis of the "disposition of catch" data available from the DAWR offshore creel survey; an evaluation of the fishermen in the fishery and their entry/exit patterns; general "dockside" knowledge of the fishery and the status of the marketing conditions and structure; the overall number of records in the database; and a certain measure of best guess.

Interpretation: Commercial pelagic fishery landings appears to have increased steadily for the last 15 years. Very few of the fishermen landing fish commercially, however, are full time fishermen. The growing charterboat industry is certainly adding to the growth of the pelagic fishery because nearly all of the charters are for trolling.

Figure 6. Guam estimated number of trolling boats.

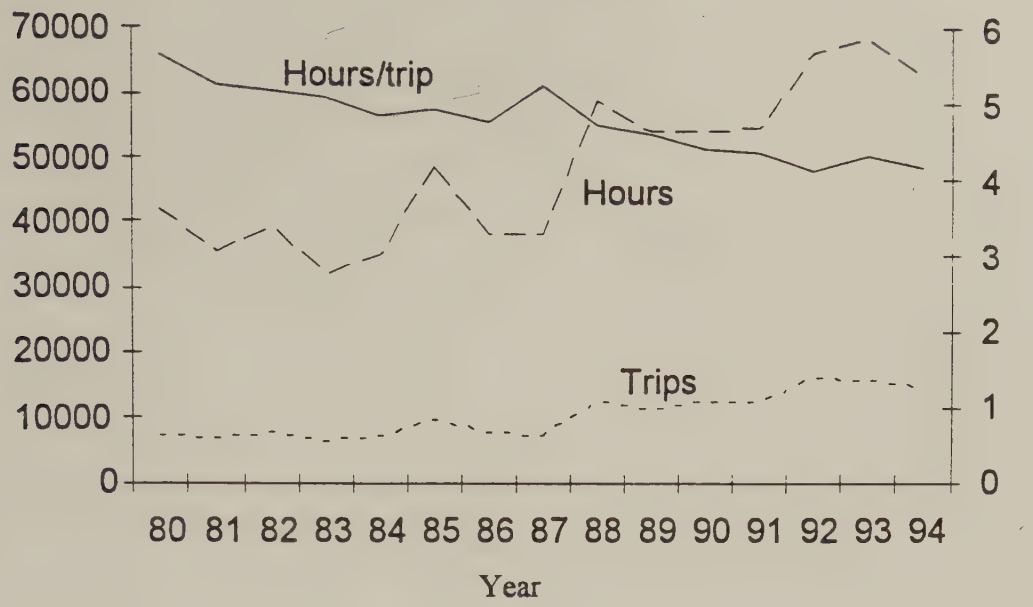


Year	Number of Boats
1980	119
1981	109
1982	196
1983	238
1984	161
1985	199
1986	182
1987	183
1988	243
1989	270
1990	262
1991	245
1992	271
1993	296
1994	**328**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. Since only a fraction of the days of the year are actually sampled, it is not possible to know the exact number of boats participating in the fishery. Therefore, a "threshold" C/E model was run a minimum of 15 times per year. The mean estimated number of boats was selected from the sorted list of model estimates.

Interpretation: The figures shown here may be an underestimate since only a single site was sampled for most years and a second site was sampled on fewer days for the years 1980-81 and 1989-94. There are undoubtedly boats participating in pelagic fisheries, that never utilized the sampled sites during any given year. Prior to 1991, this number was probably less than 50 since there were a limited number of launch sites. With the opening of the Agat Marina in 1991, a larger number of boats were not reached by the survey and the figures given for 1991 to 1994 are unrealistically low. There is a general increase in the number of small boats participating in Guam's fisheries during the past 15 years.

Figure 7. Guam annual estimated pelagic species trips, hours, and hours per trip for trolling.

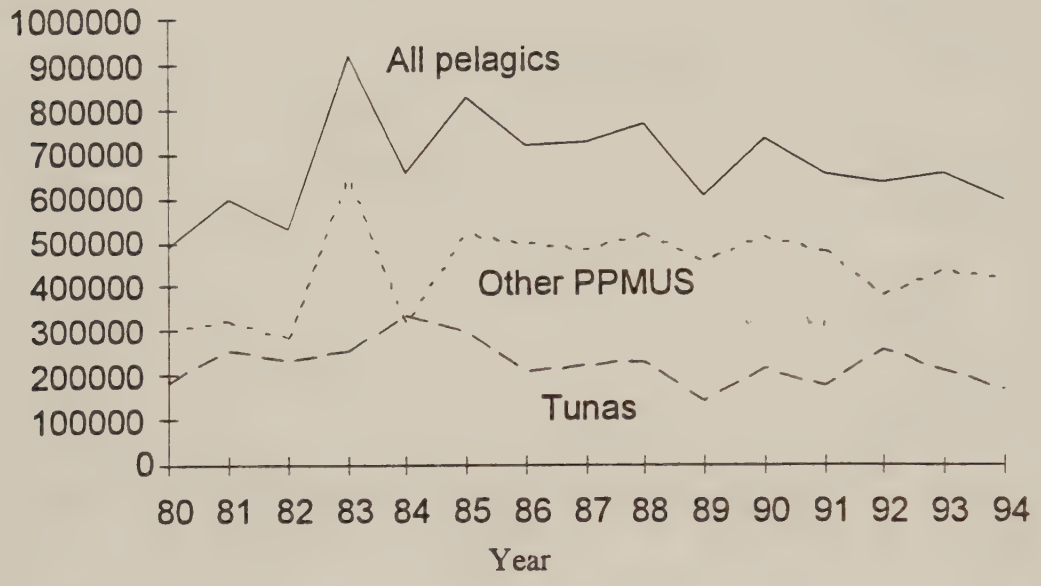


Year	Hours	Trips	Hours per Trip
1980	41,870	7,394	5.7
1981	35,430	6,763	5.2
1982	39,146	7,566	5.2
1983	32,085	6,287	5.1
1984	35,196	7,276	4.8
1985	48,823	9,900	4.9
1986	38,201	7,992	4.8
1987	38,475	7,342	5.2
1988	58,874	12,454	4.7
1989	54,119	11,725	4.6
1990	54,486	12,340	4.4
1991	54,686	12,523	4.4
1992	66,535	16,076	4.1
1993	68,609	15,810	4.3
1994	**62,616**	**15,003**	**4.2**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. The data expansion system is run on a calendar year's worth of survey data to produce catch and effort estimates for each fishing method surveyed. These plots are of the estimated boat hours spent fishing and number of trips for the trolling method as taken directly from creel survey expansion system printouts.

Interpretation: Guam's pelagic fishery continues to grow with the charterboat segment more than doubling since 1987. Record high effort as boat hours spent fishing and boat trips during 1992-93 was likely caused by a combination of record charterboat activity in 1992 and a high abundance of mahimahi in 1993. The slight drop in number of boat trips and corresponding increase in hours per trip during 1993 was most likely due to a drop in charterboat activity caused by the combination of a recession in Japan's economy and natural disasters on Guam. Since most charter trips are for a half-day, mean trip duration decreases as charterboat activity increases. Effort is expected to continue its long-term growth.

Figure 8. Guam annual estimated commercial inflation-adjusted total revenues: all pelagics, tunas, and other PPMUS.

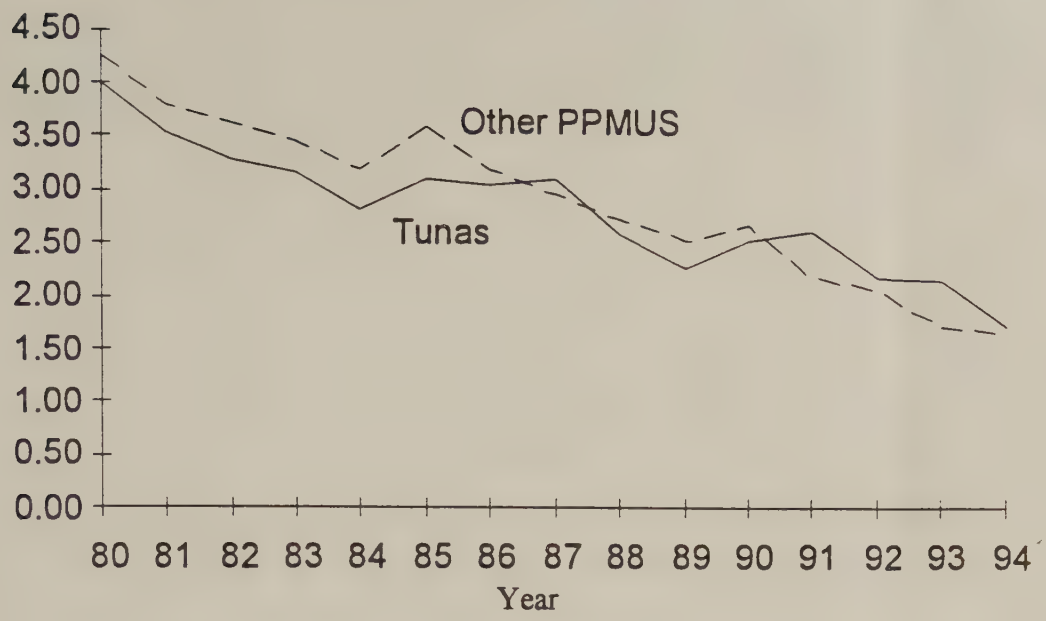


	Revenues ($)					
	All Pelagics		Tunas		Other PPMUS	
Year	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1980	149,160	493,272	54,353	179,744	90,623	299,690
1981	218,384	599,683	92,914	255,143	117,052	321,426
1982	203,847	532,449	90,719	236,958	107,573	280,981
1983	364,527	920,066	100,029	252,474	258,501	652,455
1984	283,724	658,807	143,598	333,434	135,498	314,626
1985	369,651	826,170	131,953	294,916	230,855	515,962
1986	330,302	718,737	96,395	209,755	226,935	493,810
1987	347,753	724,718	107,055	223,102	233,116	485,813
1988	386,468	765,207	114,981	227,663	261,901	518,564
1989	337,586	602,928	76,865	137,282	253,932	453,522
1990	471,241	736,550	136,321	213,069	325,372	508,556
1991	462,191	655,386	119,640	169,650	337,328	478,331
1992	492,707	634,607	195,547	251,864	289,129	372,398
1993	547,835	651,376	175,360	208,503	362,728	431,283
1994	**593,838**	**593,838**	**165,296**	**165,296**	**418,612**	**418,612**

Source and Calculation: The WPacFIN-sponsored commercial landings system. The total estimated revenue for each year was calculated by summing the revenue fields in the commercial landings database from the principle fish wholesalers on Guam, and then multiplying by the same percent coverage expansion factor as were the landings in Fig. 5. Inflation-adjusted total revenue per trip is derived from the Guam annual Consumer Price Index (CPI).

Interpretation: Revenues for all pelagic species and other PPMUS remained fairly steady from 1985 to 1990 followed by a drop since then. Revenues for tunas increased slightly from 1989 to 1992, but have fallen since then. This indicates an overall declining economic condition of the fishery when one considers that commercial landings for the same period have increased (Fig. 5).

Figure 9. Guam average price of tunas and other PPMUS.

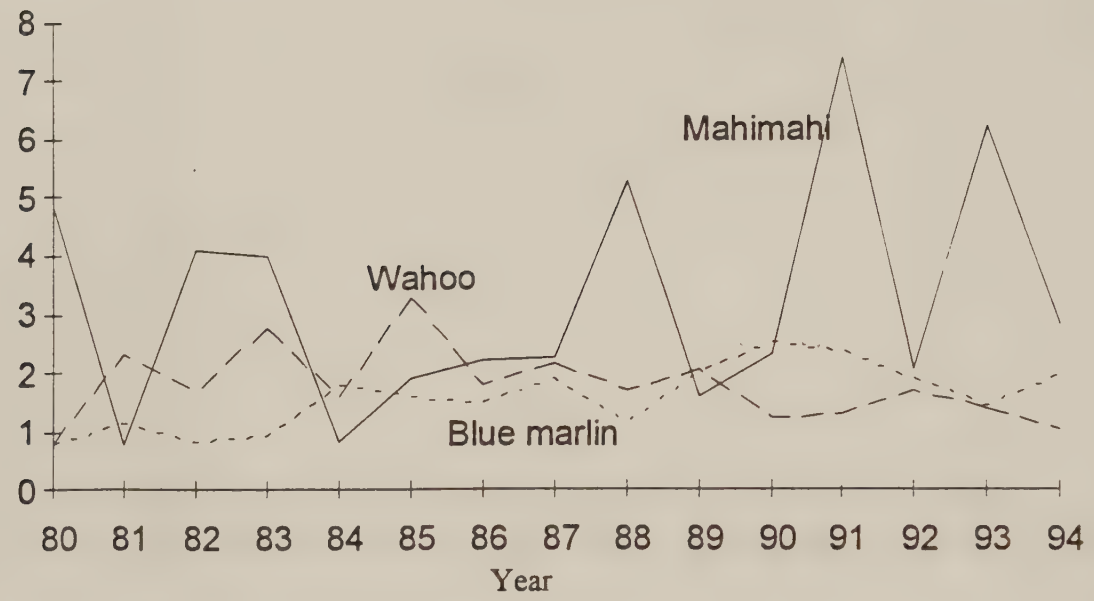


	Price ($/lb)			
	Tunas		Other PPMUS	
Year	Unadjusted	Adjusted	Unadjusted	Adjusted
1980	1.21	3.99	1.29	4.26
1981	1.29	3.53	1.39	3.81
1982	1.25	3.28	1.39	3.62
1983	1.26	3.18	1.37	3.45
1984	1.22	2.82	1.38	3.20
1985	1.39	3.11	1.61	3.60
1986	1.41	3.06	1.47	3.19
1987	1.49	3.11	1.43	2.97
1988	1.31	2.59	1.39	2.75
1989	1.28	2.29	1.42	2.54
1990	1.62	2.53	1.71	2.67
1991	1.85	2.62	1.54	2.19
1992	1.70	2.19	1.62	2.09
1993	1.82	2.17	1.45	1.72
1994	**1.73**	**1.73**	**1.67**	**1.67**

Source and Calculation: The WPacFIN-sponsored commercial landings system. The average price of the tunas and other PPMUS groups are calculated by dividing the total revenue for each by the sold weight. The inflation adjustment is made by using the Consumer Price Index (CPI) for Guam and establishing the current year figure as the base from which to calculate expansion factors for all previous years (e.g., divide the current year CPI by the CPI of any given year), and then multiplying that factor by the unadjusted average price for the given year.

Interpretation: The inflation-adjusted price of tunas and other PPMUS shows a general decline during the past 15 years. While the decline does not promote a healthy atmosphere for the commercial fishery, it does not necessarily adversely affect the charterboat industry since their success does not directly depend on the price of fish.

Figure 10. Guam trolling catch rates: mahimahi, wahoo, and blue marlin.



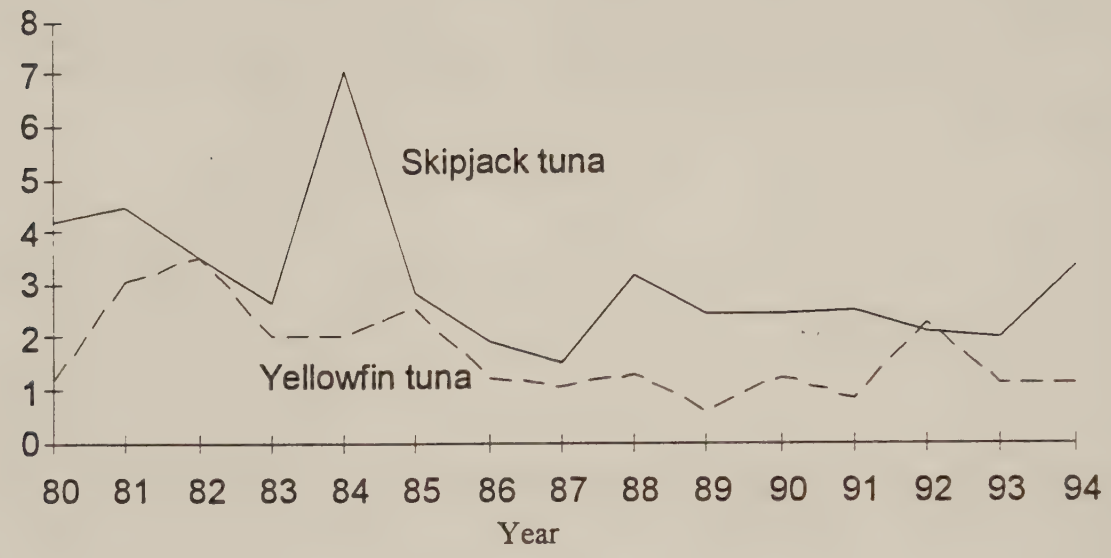
	Pounds Per Hour Fished		
Year	**Mahimahi**	**Wahoo**	**Blue Marlin**
1980	4.9	0.8	0.8
1981	0.8	2.3	1.1
1982	4.1	1.7	0.8
1983	4.0	2.8	0.9
1984	0.8	1.6	1.8
1985	1.9	3.3	1.6
1986	2.2	1.8	1.5
1987	2.2	2.2	1.9
1988	5.3	1.7	1.2
1989	1.6	2.1	2.0
1990	2.3	1.2	2.5
1991	7.3	1.3	2.4
1992	2.0	1.7	1.9
1993	6.2	1.4	1.4
1994	**2.8**	**1.0**	**1.9**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. The data expansion system is run on a calendar year's worth of survey data to produce catch and effort estimates for each fishing method. This plot and table of catch per unit of effort (CPUE) are based on the total annual landings of mahimahi, wahoo, and blue marlin, each divided by the total number of hours spent fishing (gear in use).

Interpretation: The wide fluctuations in CPUE are probably due to the high variability in the year to year abundance and availability of the stocks. However, since it is not possible to allocate

species-specific effort, effort used to target other species can also result in artificially high or low catch rates for a given species. No general trend in CPUE is apparent for mahimahi or wahoo. However there does seem to have been a general increase in the catch rate of blue marlin during the 1980s. This was probably a result of growth of the charter component of the fleet since the charter vessels tend to be larger than average and tend to target marlin more frequently than the smaller boats.

Figure 11. Guam trolling catch rates: skipjack and yellowfin tunas.

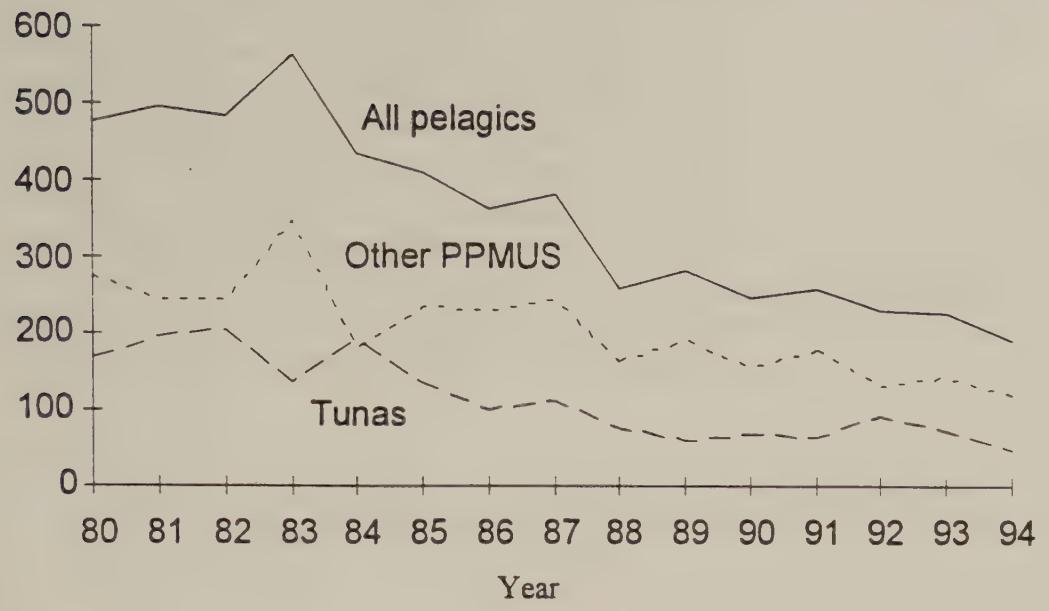


	Pounds Per Hour Fished	
Year	**Skipjack Tuna**	**Yellowfin Tuna**
1980	4.2	1.2
1981	4.5	3.0
1982	3.5	3.5
1983	2.6	2.0
1984	7.1	2.0
1985	2.8	2.5
1986	1.9	1.2
1987	1.5	1.1
1988	3.1	1.3
1989	2.4	0.6
1990	2.5	1.3
1991	2.4	0.8
1992	2.1	2.3
1993	2.0	1.0
1994	**3.3**	**1.1**

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) offshore creel sampling program and its associated computerized data expansion system files. The data expansion system is run on a calendar year's worth of survey data to produce catch and effort estimates for each fishing method surveyed. This plot and table were calculated in the same way as Fig. 10.

Interpretation: The wide fluctuations in CPUE for tunas are probably due to the high variability in the year to year abundance and availability of the stocks. However, there does seem to have been a general decline in the CPUE of yellowfin tuna between 1982 and 1989. This could have been a result of either declining abundance of the stocks, or decreasing availability due to interception by the purse-seine or longline fleets in the Guam EEZ, or both. It is also possible that a large annual effort directed at one or more other trolling species could result in an artificial decline in the CPUE of the species shown here. If the decline was due to interception by purse-seine or longline fleets, restriction of their operations from the waters near Guam and its offshore banks could alleviated the problem.

Figure 12. Guam revenues per trolling trip landing tunas or other PPMUS.



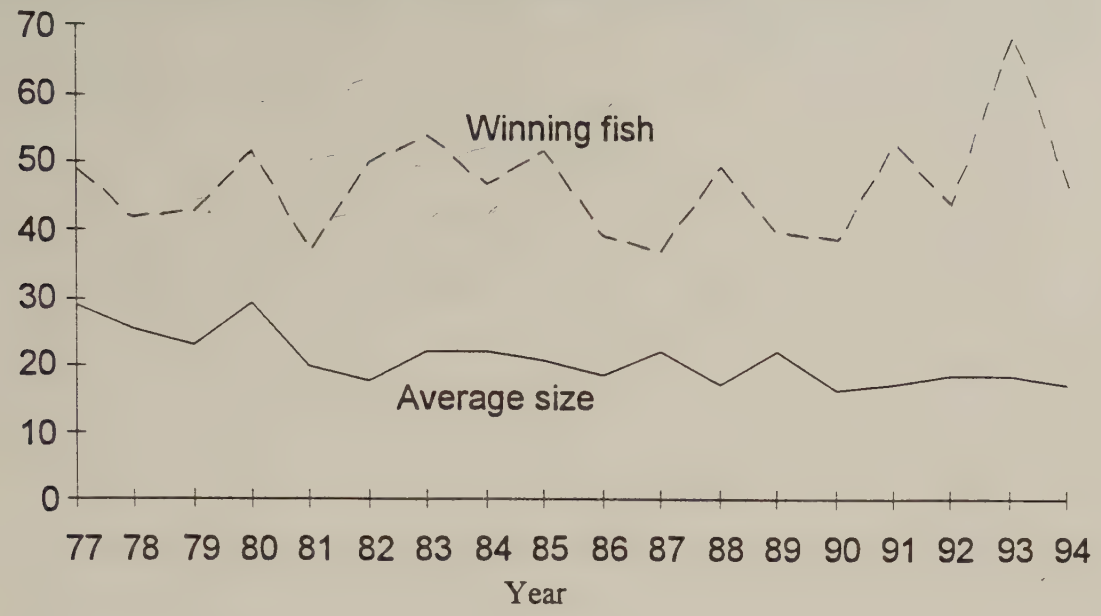
	Revenues per Trip ($)					
	All Pelagics		Tunas		Other PPMUS	
Year	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1980	144	477	50	166	84	276
1981	181	496	71	195	89	245
1982	186	485	78	205	93	243
1983	224	567	53	134	137	347
1984	189	439	83	192	78	181
1985	185	414	60	134	105	234
1986	168	365	45	99	107	232
1987	185	386	53	111	116	242
1988	132	260	37	73	83	165
1989	159	284	32	58	107	190
1990	157	246	42	65	99	155
1991	183	260	45	64	127	180
1992	181	233	69	89	102	131
1993	192	228	59	70	122	145
1994	**192**	**192**	**48**	**48**	**121**	**121**

Source and Calculation: The WPacFIN-sponsored commercial landings system. The average revenue per trip is calculated by summing the revenue of all species sold then dividing by the number of trips, and summing the revenue of all PPMUS sold then dividing by the number of trips, respectively, for any trip which landed any PPMUS. Adjusted revenue per trip is derived from the Guam annual Consumer Price Index (CPI).

Interpretation: Adjusted revenue per trip for all species, tunas and other PPMUS have experienced a general decline during the past 15 years. This can not be attributed to the trend towards

decreasing trip length since the decrease in revenues is considerably greater and since the charter fleet which tends to take shorter trips generally combine daily catches from 2-3 trips into a single trip receipt. One must be careful in interpreting these data for the Guam fishery because they are subject to biases created by marketing problems and the market structure upon which the data collecting system is based. For instance, 1988, 1991, and 1993 were record high years for abundance and landings of mahimahi. One might expect the per trip landings to be high for a year which had record landings. However, because of the glut on the market during the mahimahi season, and because of other marketing problems, the per trip revenue was unusually low. This was partly because purchase limits were placed on fishermen, e.g., only certain fishermen's catches would be purchased (Coop members), and even then a 50-lb maximum limit was occasionally placed on mahimahi. This caused fishermen to either stop fishing at all, stop fishing when they caught 50 lb, or start marketing some of their catches elsewhere, which further increased Coop marketing problems.

Figure 13. Guam International Fishing Derby - average size and size of winning fish: wahoo.



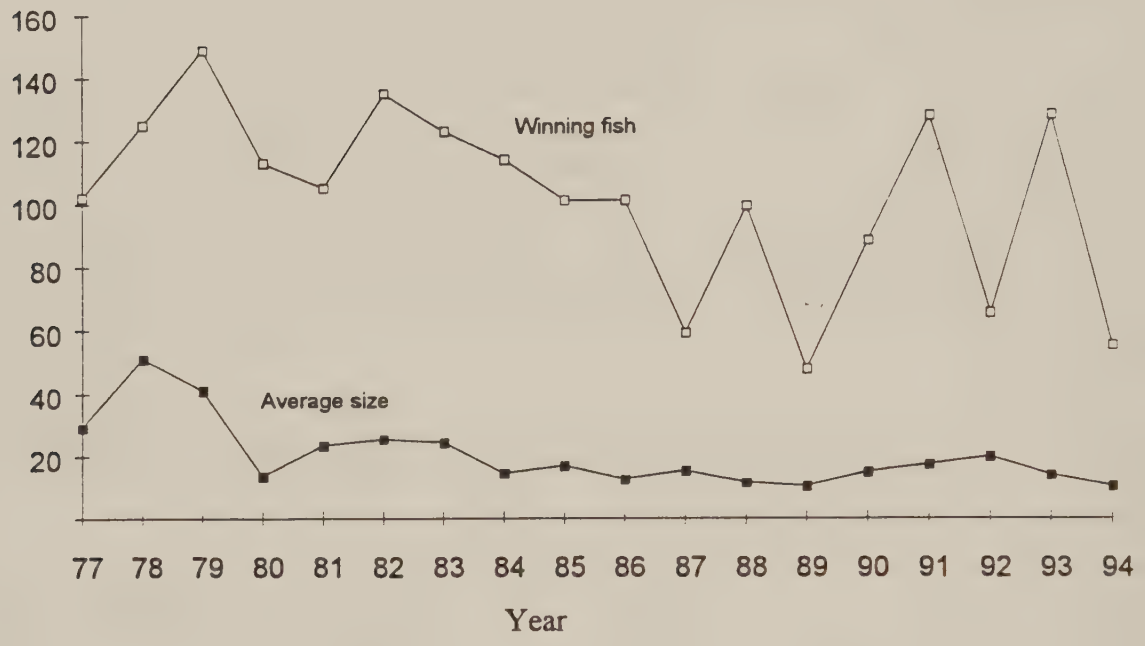
Year	Number Caught	Average Size (lb)	Winning Fish (lb)
1977	7	28.7	49
1978	9	25.1	42
1979	11	23.2	43
1980	12	29.5	52
1981	60	20.0	37
1982	33	17.6	50
1983	36	22.1	54
1984	46	22.3	47
1985	98	20.7	52
1986	16	18.7	39
1987	31	22.3	37
1988	72	17.3	49.5
1989	59	22.0	39.5
1990	34	16.2	38.9
1991	40	17.4	52.9
1992*	38	18.7	44.0
1993	19	18.6	69.2
1994	**112**	**17.3**	**47.0**

*Third day of derby canceled; results based on 2 days of fishing.

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) annual reports. The Guam International Fishing Derby (GIFD) is an annual three-day event that occurs in July or August. Most of the wahoo caught are measured or weighed by derby officials. The figures here include some fishes whose weights are based on an average or estimate.

Interpretation: No general trend is apparent over the last 17 years.

Figure 14. Guam International Fishing Derby - average size and size of winning fish: yellowfin tuna.



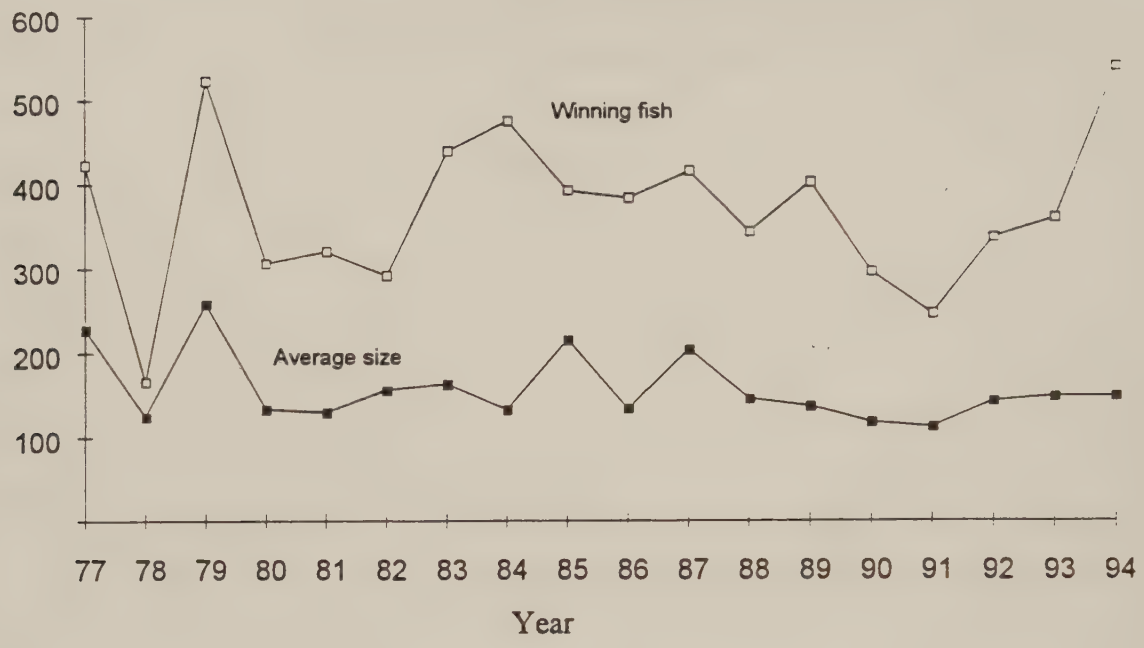
Year	Number Caught	Average Size (lb)	Winning Fish (lb)
1977	18	29.3	102
1978	11	51.2	125
1979	34	41.2	149
1980	50	13.7	113
1981	109	23.4	105
1982	205	25.6	135
1983	100	24.5	123
1984	59	14.6	114
1985	137	17.0	101
1986	71	12.6	101
1987	116	15.3	59
1988	161	11.6	99
1989	81	10.5	47.5
1990	81	14.9	88
1991	102	17.4	127.4
1992*	99	19.8	65.0
1993	103	14.1	127.6
1994	**56**	**10.5**	**54.9**

*Third day of derby canceled; results based on 2 days of fishing.

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) annual reports. The Guam International Fishing Derby (GIFD) is an annual three-day event that occurs in July or August. Most of the yellowfin tuna caught are measured or weighed by derby officials. The figures here include some fishes whose weights are based on an average or estimate.

Interpretation: The size of the winning fish has fluctuated widely since 1986. This may indicate a lowered abundance of relatively large fishes since then. There seems to have been a slight recovery in the average size from 1989 to 1992 following a general decline during the previous 10 years. However, the average size has declined since then.

Figure 15. Guam International Fishing Derby - average size and size of winning fish: blue marlin.



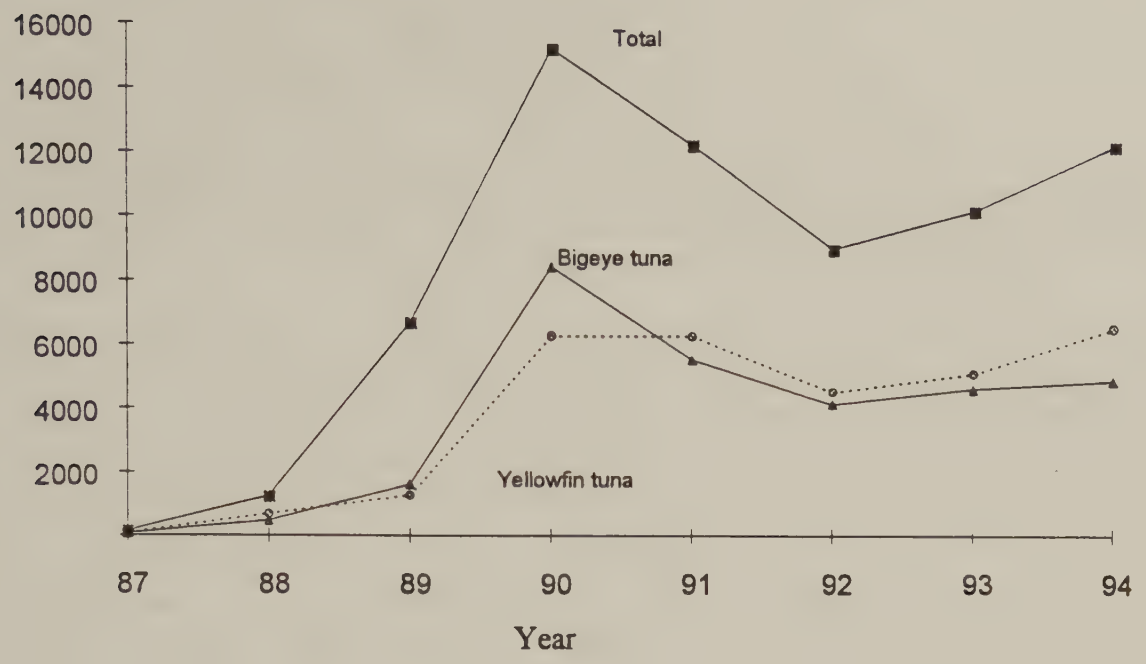
Year	Number Caught	Average Size (lb)	Winning Fish (lb)
1977	9	228.4	423
1978	9	125.2	166
1979	6	258.4	523
1980	12	133.6	306
1981	34	130.1	320
1982	12	156.6	291
1983	13	163.6	439
1984	47	133.2	475
1985	17	215.2	392
1986	47	134.1	383
1987	43	203.9	415
1988	58	145.7	342.5
1989	86	136.7	402
1990	64	117.9	295
1991	61	112.0	245
1992*	42	142.5	336.0
1993	27	148.4	358.5
1994	**45**	**148.6**	**538.5**

*Third day of derby canceled; results based on 2 days of fishing.

Source and Calculation: The Division of Aquatic and Wildlife Resources (DAWR) annual reports. The Guam International Fishing Derby (GIFD) is an annual three-day event that occurs in July or August. Most of the billfishes caught are measured or weighed by derby officials. The figures here may include a few fishes whose weights are based on an average or estimate.

Interpretation: No general trend is apparent over the last 17 years. However there seems to have been a slight decline in the size of the winning fish and average size between 1987 and 1991 followed by a recovery during the last two years.

Figure 16. Annual Guam longline landings from primarily foreign longliners fishing primarily outside the Guam EEZ.



Year	Total (tons)	Bigeye tuna (tons)	Yellowfin tuna (tons)
1987	144	60	72
1988	1,236	462	682
1989	6,691	1,615	1,274
1990	15,278	8,433	6,283
1991	12,264	5,549	6,279
1992	9,017	4,150	4,537
1993	10,207	4,630	5,126
1994	**12,283**	**4,896**	**6,553**

Source and Calculation: Guam Department of Commerce. Pre-1990 data was extracted directly from transshipment agent's files. Beginning in 1990, a mandatory data submission program was implemented.

Interpretation: Annual landings of the primarily foreign longline fishing fleet which transships its catch out of Guam have ranged up to 15,278 t since the fishery began in the late 1980s. The majority of landings have been made by Japanese (72%) vessels, followed by Taiwanese (26%) and Korean (1%) vessels, with the other 1% from vessels of four other flags, including the USA. Overall landings have been comprised of 50% bigeye tuna, 46% yellowfin tuna, 4% various marlin species, and less than 1% of all other species combined.

Appendix 3

Hawaii

Introduction

This report contains information from two sources: the Hawaii Department of Land and Natural Resources Division of Aquatic Resources (HDAR) and the National Marine Fisheries Service Honolulu Laboratory (NMFS). The sources of data are noted with each table and graph.

The staff of the HDAR compiled the data on the non-longline Hawaii pelagic fisheries in calendar year 1994. Data on troll, handline and baitboat landings, CPUE, and revenue came exclusively from the HDAR commercial catch reporting system. Historical troll and handline data (1987-91) had been revised using HDAR data to maintain consistency with 1992-94 data. Please note, therefore, that information reported in annual reports previous to 1992 are not directly comparable to this 1994 report.

The HDAR summaries were produced from the State's mandatory commercial catch reporting system. Every fisherman, including captain and crew, who sells any marine species is required by the State to have a Commercial Marine License and, unless specifically exempted[1], is required to submit a catch report monthly to the HDAR.

A total of 3,498 fishermen were licensed in calendar year 1994, of which 2,571 were required to report. As of April 1995, the HDAR had received 27,907 reports, or 89% of the 31,302 expected. The HDAR asked fishermen to identify their primary fishing gear/method on the Commercial Marine License at the time of licensing. This did not preclude fishermen from using other gears or methods, but indicated what they considered to be their primary method (numbers in parentheses indicate change from fiscal year 1993). According to the licenses, 1,514 were trollers (-4.5%), 595 were longliners (-12.8%), 150 (-6.8%) were tuna handliners (*ika-shibi* or *palu-ahi*), and 62 were baitboat fishermen (-12.9%), for a total of 2,313 pelagic fishermen (-7.1%). Of these, 1,497 trollers (-4.5%), 115 longliners (-20.1%), 129 handliners (-10.4%), and 6 baitboat fishermen (-45.4%) were required to submit catch reports to DAR, for a total of 1,657 (-6.5%).

As in the 1992 and 1993 pelagics annual reports, these summaries represent recent changes in the HDAR Commercial Fisheries Statistical Charts. Fishermen must report the area where they made their catches using statistical charts provided by the HDAR. A new set of charts went into effect in July 1990, which provided new statistical area codes for areas that were not covered by old charts. This accommodated fishermen who were fishing beyond the boundaries of the old charts.

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[1] Only one person per vessel is required to submit a catch report. This person is usually the captain or a representative of the owner. Crew members are generally not required to submit catch reports.

The data presented here include data from areas covered by the new 1990 charts, covering the entire Hawaiian Archipelago.

The HDAR does not collect recreational fisheries data because no State statutory authority exists to do so. The HDAR contracted a one-time survey of small-boat commercial and recreational fishermen in 1990-91 at ports around the island of Oahu, at the request of the Western Pacific Regional Fishery Management Council and with funding and guidance from the NMFS. The data from the one-year survey were analyzed by the Honolulu Laboratory. A preliminary report is available from the Honolulu Laboratory or from the Council[2]. The lack of long-term recreational data, lack of data on unlicensed commercial fishermen, and lack of validation of current data sets remain serious problems.

The staff of the NMFS Fishery Monitoring and Economics Program (FMEP) compiled the data and prepared the estimates of the pelagic longline fishery. Estimates for longline landings, CPUE, and revenue came from the NMFS longline logbooks and the NMFS/HDAR wholesale market monitoring programs. Estimates of 1994 longline landings were made using 1994 logbook data in numbers of fish and 1994 average weights. Statistics on longline landings were estimated by the NMFS using a procedure explained more fully in a separate NMFS report "Western Pacific Pelagic Fisheries in 1991"[3].

The NMFS estimates for 1987-90 were compiled by extrapolating market monitoring information on a substantial sample of longline trips. The NMFS estimates for 1991-94 were constructed by combining NMFS figures on average size of longline fish landed in Honolulu with NMFS longline logbook figures on the number of longline caught fish which were recorded as "kept".

The NMFS estimates for 1994 are preliminary because of the possibility of late arriving logbooks and re-compilation of average weights from the market monitoring program. The final longline logbook numbers will be reported by the NMFS in a separate annual report on the longline logbook program, and the final estimates of longline landings will be reported in an additional NMFS report. These reports will be completed by summer 1995.

Summary

Total pelagic landings decreased by 25%, nominal revenue decreased 15%, and adjusted revenue fell by 18%. Almost 80% of the drop in landings was caused by a 6.6 million pound drop in swordfish landings. Most of the other species showed relatively little change in landings. Non-tuna PPMUS landings decreased 36%, nominal revenue decreased 32% and adjusted revenue fell 34%. Total tuna landings decreased 5%, but nominal revenue increased 9% and adjusted revenue

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[2] Hamm, D.C., and H.K. Lum. 1992. Preliminary results of the Hawaii small-boat fisheries survey. NMFS Southwest Fisheries Science Center, Honolulu Laboratory, Admin. Rept. H-92-88.

[3] Ito, R.Y. 1992. Western Pacific Pelagic Fisheries in 1991. NMFS Southwest Fisheries Science Center, Honolulu Laboratory, Admin. Rept. H-92-15.

was up by 6%. As in recent years, non-tuna PPMUS landings and revenue exceeded tuna landings and revenue, largely due to the swordfish longline fishery. Inflation adjusted prices for pelagic species rose in 1994.

Longline trends

The Hawaii-based longline fishery was the largest and most prominent domestic commercial fishery in Hawaii in 1994. Longline landings were estimated at 18.4 million pounds worth about $42.3 million in 1994. This represents a 27% decrease in landings and a 25% decrease in inflation-adjusted revenue from the previous year. There were many changes in the Hawaii-based longline fishery in 1994. This is a short summary on what transpired in 1994.

The Western Pacific Regional Fishery Management Council's moratorium on longline vessels, in place since April 1991, was replaced with a limited entry program (Amendment 7 to the Pelagic Species FMP). Some of the features of the limited entry program is that permits can be freely transferred and vessels upgraded, to a length limit. Federal limited entry permits are capped at 168 Hawaii-based longline vessels.

The NMFS mandatory observer program began in February of 1994. The focus of the observer program is interaction of longline gear with sea turtles. The observer program is run by the NMFS Southwest Region. Recently a workshop was also held at the Honolulu Laboratory to discuss methods to improve the survivability of turtles taken incidentally in the longline fishery.

There were 125 longline vessels operating out of Hawaii in 1994. Although this is a slight increase in the number of vessels, many vessels emigrated over the course of the year. Most of the vessels leaving originally came from the East Coast or U.S. Gulf of Mexico area. Some of the reasons mentioned for leaving Hawaii were the high cost of operations and maintenance in Hawaii, poor swordfish catch rates, anticipation of better fishing elsewhere, and to keep their longline permits active elsewhere in the U.S. There were 14 less vessels fishing in the fourth quarter of 1994 in comparison to the same period in 1993. These changes would account for much of the decline in longline landings and revenue.

Hawaii-based longliners completed 1,107 trips in 1994. The number of trips has declined throughout the 1991-94 period. Some of the reasons leading to the decline in trips are less vessels fishing since 1991 as well as an increase in trip length. The total number of days fished in 1994 decreased to its lowest level since the logbook collection program was initiated in 1991. The average number of days fished per trip peaked in 1993 and decreased slightly in 1994. In 1994, there were 12.2 million hooks set. Hooks set inside the EEZ increased by about 1 million while hooks set outside the EEZ decreased by two million in 1994. The total number of hooks was at its lowest level in 1992 and peaked in 1993.

Bigeye tuna became the largest component of the longline landings by weight in 1994. Although bigeye tuna landings decreased slightly in 1994, the decrease was not as dramatic as swordfish. Swordfish landings decreased by 46% in 1994. Even though swordfish landings decreased substantially, swordfish still managed to place second in composition. All other species of billfish,

with the exception of spearfish, also decreased in 1994. Mahimahi increased 30% and retained its third place ranking in composition. Albacore, the fourth largest component of the landings, increased 21% while yellowfin tuna deceased slightly. Shark landings remained about the same. Very few sharks are returned whole; most of the sharks were finned. Some 40,000 lb of northern bluefin tuna were also landed.

Catch per unit effort (CPUE) is measured by the number of fish caught per 1,000 hooks set. Swordfish CPUE declined by 41% in 1994. The low swordfish CPUE influenced some swordfish longliners to switch target species in the latter part of the year. There was a concurrent rapid rise in bigeye CPUE during the fall season. Striped marlin CPUE decreased by 33%. There were only slight changes in CPUE for all the tuna species. Blue shark CPUE remained highest of all shark species. Blue shark did drop 20% in 1994. The highest CPUE of other PPMUS was mahimahi. Mahimahi CPUE rose 38% in 1994. Other miscellaneous PPMUS species have much lower CPUE in comparison.

Other Pelagic Fisheries Trends

In general, the commercial troll and pelagic handline fisheries showed moderate changes in 1994. Total estimated landings for troll and handline rose about 9%. Estimated troll and handline nominal (+25%) and inflation-adjusted revenues (+21%) rose as well. Troll trips were about the same as 1993 and remained well within the 1986-1994 average. Handline trips declined about 5%, but were still near the long-term average.

Troll and handline landings of mahimahi rose 13% and were near the long-term average. Blue marlin landings decreased 6%. Wahoo landings dropped 19% and were below the long-term average. Striped marlin landings, after the peak in 1993, dropped 50% but returned to average levels. Yellowfin increased slightly, but remained near the long-term average. Bigeye tuna landings were much higher (+25%) and well above the long-term average. Skipjack landings fell 13% but were near the long-term average..

Catch rates for major pelagic species caught by trollers were variable compared to 1993. Mahimahi catch per trip (CPT) rose 15% and was significantly higher than the long-term average. Yellowfin CPT, which varies widely, was 47% higher than 1993, but still within range of the long-term average. Catch rates for wahoo, blue marlin, and skipjack declined by varying percentages in 1994, but were generally near long-term averages. Catch rates for handliners generally declined, except for handline bigeye, which was 3.6 times higher than 1993's CPT, and double the previous high in 1992. The handline mahimahi CPT has remained high since 1991. The handline yellowfin catch rate has risen steadily since 1990 and in 1994 was second only to the record peak of 1993.

Baitboat landings (-50%), nominal revenue (-38%), and inflation-adjusted revenue (-39%) showed a substantial decline in 1994. Baitboat trips declined 41% and reached a new low. The skipjack catch rate was 27% lower than 1993, but was well within the range of the long-term average.

Recommendations

1. NMFS and HDAR should extend the data in tables and graphs in the 1995 Hawaii module back to 1970, so that long time series data are available.

2. An analysis of the North Pacific swordfish fishery, discussing the declines in total catch and CPUE in detail, is needed. NMFS should prepare a special report on the fishery to be included with the 1995 report. The appearance of bluefin tuna in the longline catch also needs to be discussed.

3. NMFS should separate blue shark landings from total shark landings in NMFS logbook summaries.

4. HDAR field personnel should be encouraged to improve species identification by state license holders, as well as data coding, for marlins (especially blue and striped) and ahi (bigeye and yellowfin).

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Table 1. Hawaii domestic commercial landings, revenue and prices, 1993-94.

Species	1993 Pounds Landed (x 1,000)	1993 Ex-vessel Revenue (x $1,000)	1993 Ave. Price ($/lb)	1994 Pounds Landed (x 1,000)	1994 Ex-vessel Revenue (x $1,000)	1994 Ave. Price ($/lb)
Swordfish	13,500	26,900	2.00	6,900	16,100	2.32
Blue marlin	1,500	1,200	0.90	1,500	1,600	1.11
Striped marlin	1,300	1,600	1.24	800	1,400	1.67
Other billfish	300	300	0.95	300	300	1.30
Mahimahi	800	1,400	1.98	1,000	1,800	2.04
Wahoo	500	1,000	2.19	400	1,000	2.88
Moonfish*	-	-	-	500	600	1.10
Sharks	2,600	3,000	1.15	1,800	1,100	0.60
Non-Tuna PPMUS Subtotal	**20,500**	**35,400**	**na**	**13,200**	**23,900**	**1.84**
Bigeye tuna	4,200	14,500	3.44	4,300	15,400	3.55
Yellowfin tuna	3,700	8,300	2.33	3,900	9,600	2.52
Albacore	1,200	1,500	1.19	1,400	1,700	1.26
Other tunas	2,600	3,000	1.17	1,500	3,000	2.10
Tuna PPMUS Subtotal	**11,700**	**27,300**	**na**	**11,100**	**29,700**	**2.71**
Other pelagics	400	500	1.05	0	0	1.60
TOTAL	**32,600**	**63,200**	**1.95**	**24,300**	**53,600**	**2.24**

* Moonfish was counted in other pelagics prior to 1994.

Source and Calculation: NMFS estimates based on federal longline logbooks (number landed) and shoreside monitoring (average weight per fish) by NMFS and HDAR, and HDAR commercial catch reports for non-longline gears. NMFS estimates were made based on the currently available data: updates of these figures are expected by mid-year. Totals were calculated by summing separate estimates for longline, baitboat (pole-and-line or aku boat), main Hawaiian Islands troll and handline, and Northwestern Hawaiian Islands landings. Estimates for troll, handline, and baitboat are based on HDAR data but are compensated by NMFS for end of the year delinquencies. Detailed information on the estimation procedure is available in Ito (1992). Numbers rounded to nearest 100,000 and summed.

Interpretation: Total pelagic landings decreased by 26% and inflation-adjusted revenue decreased by 18%. Most of the non-tuna PPMUS showed a decrease in landings, with the largest occurring for swordfish (49%). Mahimahi, however, showed an increase of 25%. In contrast, nominal revenue for four of the non-tuna PPMUS landings increased but only marginally. Landings (and nominal revenue) for bigeye, yellowfin, and albacore tuna rose by 3-16% (6-16% for revenue). Landings of other tunas (primarily skipjack) fell, but there was a noteworthy landing of 40,000 lb ($330,000) of bluefin tuna was made for the first time in 1994. Price increased for 10 species and as a weighted average by 15% (12% in inflation-adjusted prices). As in recent years, non-tuna PPMUS landings exceeded tuna landings, but in contrast to this trend tuna revenue exceeded non-tuna PPMUS revenue.

Table 2. Hawaii commercial pelagic landings and revenue by gear, 1993-93.

Gear	Pounds Landed (x 1,000)	Pounds Sold (x 1,000)	Ex-vessel Revenue (x $1,000)	Average Price ($/lb)
		1993		
Baitboat	2,100	2,100	2,400	1.13
Handline	2,100	2,100	3,900	1.84
Longline	26,000	26,000	53,300	2.05
Trolling	2,600	2,200	3,800	1.78
Other	0	0	0	1.09
TOTAL	**32,800**	**32,400**	**63,400**	**1.95**
		1994		
Baitboat	1,000	1,000	1,500	1.54
Handline	2,200	2,200	4,500	2.07
Longline	18,300	18,300	42,300	2.30
Trolling	2,900	2,500	5,100	2.01
Other	0	0	0	5.50
TOTAL	**24,400**	**24,000**	**53,400**	**2.32**

Source and Calculation: NMFS estimates and HDAR commercial catch report data, as in Table 1 notes. Pelagic species only. 1994 data are preliminary. Rounded to nearest 100,000; due to rounding errors, the totals here and in Table 1 do not match.

Interpretation: Landings and revenues decreased for baitboat and longline while they increased for handline and trolling. All prices increased.

Table 3. Hawaii longline landings, catch per unit effort, and revenue, 1993-94.

Species	1993 Landings (x 1,000 lb)	1993 CPUE (No. caught per 1000 hooks)	1993 Revenue (x $1,000)	1994 Landings (x 1,000 lb)	1994 CPUE (No. caught per 1000 hooks)	1994 Revenue (x $1,000)
Blue marlin	740	0.37	630	810	0.38	1,040
Swordfish	13,050	5.86	26,490	6,910	3.52	16,030
Striped marlin	1,060	1.25	1,090	750	0.93	1,220
Other billfish	220	0.41	200	220	0.42	270
Mahimahi	310	1.89	390	380	2.62	600
Wahoo	140	0.33	270	90	0.21	240
Moonfish	450	-	390	520	0.42	570
Pomfrets	-	-	-	20	0.10	30
Sharks	2,730	1.28	200	1,790	1.37	220
Non-Tuna PPMUS Subtotal	**18,700**	**na**	**30,660**	**11,490**	**na**	**20,220**
Bigeye tuna	4,730	4.08	16,890	4,010	3.99	16,120
Yellowfin tuna	1,430	1.16	3,920	1,370	1.12	3,850
Albacore	1,010	1.69	1,220	1,190	2.18	1,490
Bluefin	-	-	-	40	0.01	330
Other tuna	310	0.40	3,270	150	0.55	200
Tuna PPMUS Subtotal	**7,480**	**na**	**25,300**	**6,760**	**na**	**21,990**
Misc. pelagics	110	0.55	530	110	0.45	100
TOTAL	**26,290**	**na**	**56,490**	**18,360**	**na**	**42,310**
Number of hooks set x 1000		12,988			12,217	

Source and Calculation: NMFS estimates based on NMFS longline logbook data and NMFS/HDAR shoreside monitoring data. 1994 data are preliminary.

Interpretation: Landings and nominal revenue declined for all species 30% and 25%, respectively, 39% and 34% for non-tuna PPMUS, respectively, and 10% and 13% for tunas, respectively. Swordfish recorded the largest decline 47% (39%). Many catch rates were down, with only mahimahi, moonfish, and albacore showing increases.

Table 4. Average estimated round weight (in pounds) of fish by gear type, 1987-94.

	Non-Tuna PPMUS					Tunas			
Year	Swordfish	Blue marlin	Striped marlin	Mahimahi	Wahoo	Bigeye	Yellowfin	Albacore	Skipjack
				Longline					
1987	129.3	161.4	66.2	21.1	33.3	76.3	81.9	62.3	--
1988	119.2	157.3	56.9	20.0	31.9	83.2	102.5	59.7	--
1989	131.1	164.7	61.5	23.0	34.6	77.0	103.7	62.0	--
1990	147.6	198.4	61.5	18.7	36.0	79.8	121.9	61.2	--
1991	152.6	174.1	56.2	14.8	31.6	86.3	116.6	51.3	19.7
1992	178.1	167.1	69.7	10.9	34.7	77.0	97.3	46.7	16.4
1993	171.6	154.0	65.0	12.8	32.4	89.3	95.0	46.2	17.0
1994	**160.5**	**172.2**	**66.5**	**12.0**	**34.2**	**82.3**	**99.6**	**44.9**	**17.3**
				Troll and Handline					
1987	--	212.1	67.3	18.8	19.5	19.6	27.6	--	8.9
1988	--	181.6	60.3	17.2	21.1	58.9	31.5	--	11.1
1989	--	185.7	67.9	19.9	20.9	34.0	35.4	--	13.6
1990	--	243.3	74.8	19.1	21.9	25.3	51.6	--	10.6
1991	--	179.2	60.6	13.5	18.8	20.4	26.0	--	14.5

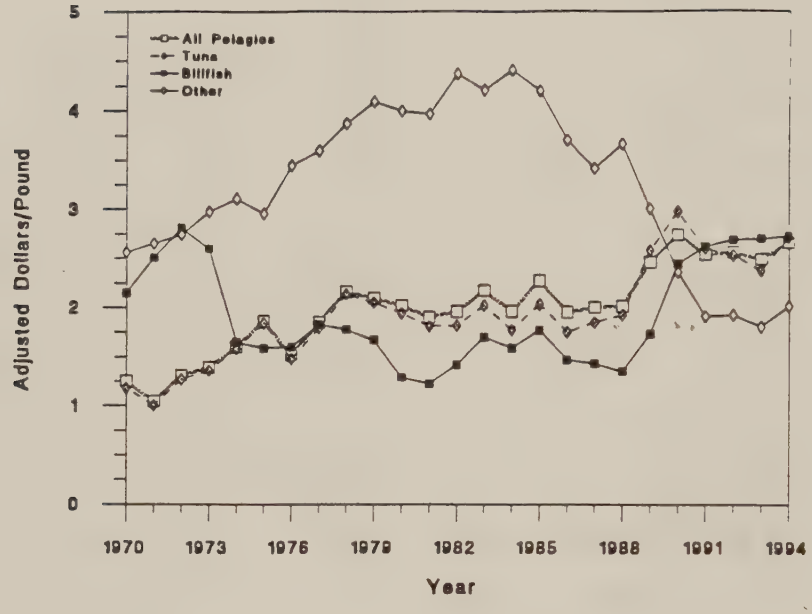
Source and Calculation: NMFS estimates from the NMFS/HDAR shoreside monitoring program. The dressed weight of the landed fishes were raised to estimated round weight and averaged. The 1991-93 average weights were recalculated this year as weighted averages with the weights proportional to the fishing trip coverage rate at the monitoring sites at the auction in Honolulu and at independent dealers. Low coverage precludes making estimates for troll and handline in 1992 through 1994.

Table 5. Hawaii longline vessel activity, 1991-94.

	1991	1992	1993	1994
Tuna Trips	556	458	542	384
Ave. miles to first set	240	260	222	275
Ave. days fishing	9	10	10	10
Mixed Trips	823	530	319	193
Ave. miles to first set	276	404	520	337
Ave. days fishing	7	10	12	10
Swordfish Trips	291	277	331	264
Ave. miles to first set	585	733	811	796
Ave. days fishing	14	18	19	19

Source and Calculation: The NMFS Honolulu Lab's Fishery Monitoring and Economics Program and the Hawaii Fishing Industry & Vessel Economics project (a PFRP project) compiled a picture of Hawaii domestic longline activity based on federal logbooks for 1991-94. They calculated the average distance and time to the first setting of gear for each longline trip. The average distance in miles from Honolulu was calculated by linear latitude-longitude pairs. In 1994, the average tuna trip required 1.25 days travel to the first set (275 miles), the average mixed trip required 1.53 days (337 miles), and the average swordfish trip required 3.6 days (796 miles). The composition of the Hawaii longline fleet, including number and type of participants and the trip targets of continuing vessels, changed substantially from 1993 to 1994.

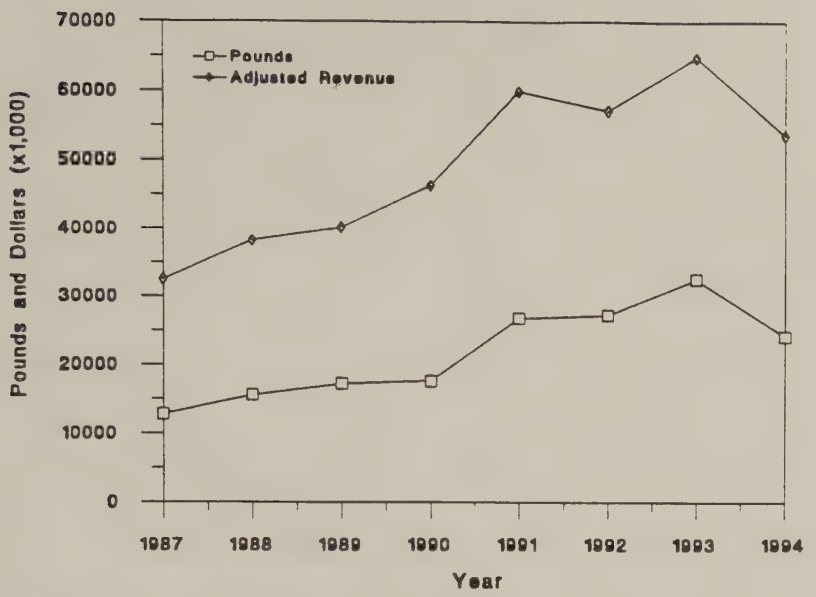
Figure 1. Inflation-adjusted prices of pelagics.



Year	All Pelagics	Tuna	Billfish	Other
1970	1.25	1.18	2.15	2.56
1971	1.04	1.00	2.51	2.65
1972	1.31	1.27	2.81	2.74
1973	1.39	1.36	2.60	2.98
1974	1.60	1.58	1.65	3.11
1975	1.86	1.84	1.59	2.96
1976	1.52	1.48	1.60	3.45
1977	1.85	1.79	1.83	3.60
1978	2.16	2.14	1.78	3.87
1979	2.10	2.05	1.67	4.09
1980	2.02	1.94	1.29	4.00
1981	1.90	1.81	1.22	3.97
1982	1.96	1.82	1.42	4.37
1983	2.17	2.02	1.70	4.21
1984	1.96	1.77	1.59	4.41
1985	2.27	2.03	1.77	4.20
1986	1.95	1.75	1.47	3.71
1987	2.00	1.85	1.43	3.42
1988	2.01	1.92	1.35	3.67
1989	2.46	2.58	1.73	3.01
1990	2.74	2.98	2.44	2.36
1991	2.54	2.60	2.62	1.91
1992	2.56	2.53	2.69	1.92
1993	2.49	2.37	2.70	1.80
1994	**2.66**	**2.71**	**2.73**	**2.01**

Source: NMFS estimates from NMFS/HDAR shoreside monitoring program and HDAR commercial catch data. All gears combined. Adjusted for inflation using Honolulu Consumer Price Index, adjusted to 1994 level.

Figure 2. Hawaii commercial pelagic landings and revenue.

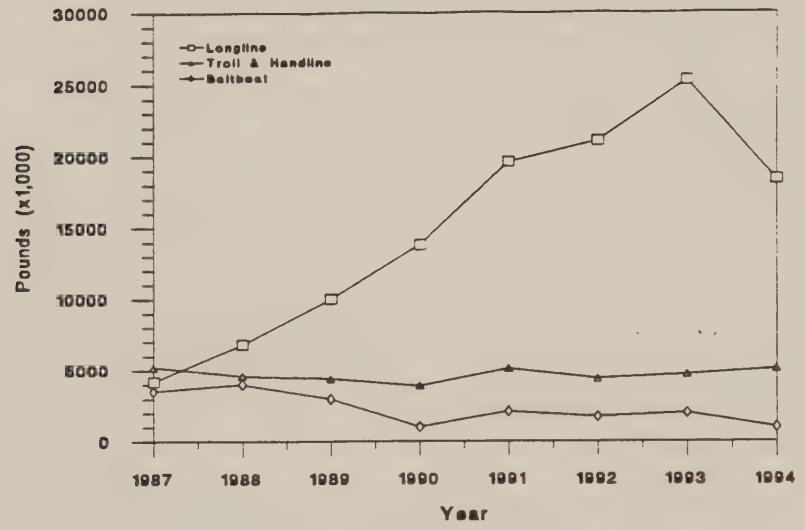


Year	Pounds (x 1,000)	Revenue (x $1,000) Nominal	Revenue (x $1,000) Adjusted
1987	12,800	23,300	32,800
1988	15,600	28,900	38,300
1989	17,300	32,000	40,200
1990	17,700	39,500	46,300
1991	26,900	54,300	59,900
1992	27,400	54,200	57,100
1993	32,600	63,200	64,900
1994	**24,300**	**53,600**	**53,600**
Mean ±SD	21,825 ±6,488	43,625 ±13,650	48,475 ±10,723

Source and Calculation: Landings and revenue data were collected by NMFS and HDAR. See notes to Table 1 for estimation procedures. Nominal revenue is converted to inflation-adjusted revenue (1994 level) with the Honolulu Consumer Price Index (CPI-U). Estimates were rounded to nearest 100,000 pounds or dollars.

Interpretation: Total pelagic harvest decreased by 25% in weight and 17% in adjusted revenue from the previous year. However, landings and adjusted revenue were slightly higher than the long-term mean.

Figure 3. Hawaii total commercial pelagic landings by gear type.

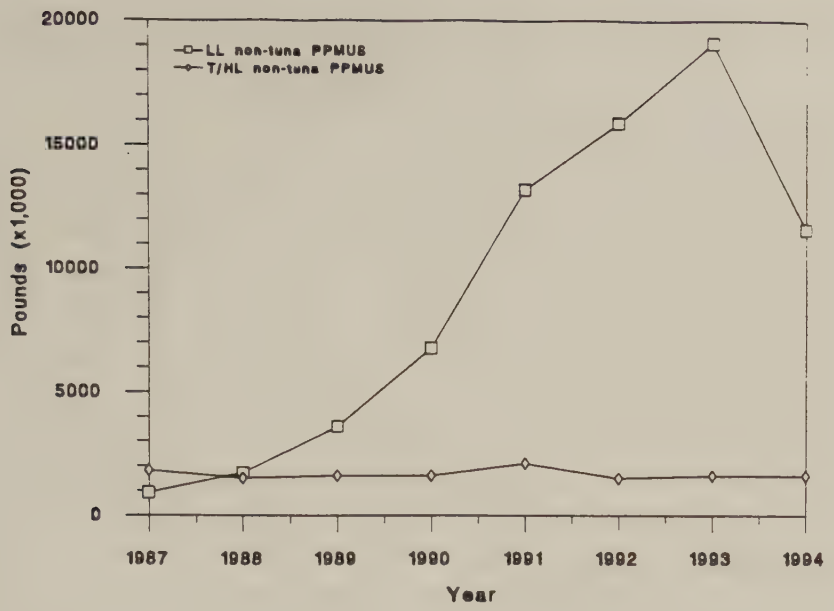


	Pounds landed (x 1,000)		
Year	**Longline**	**Troll & Handline**	**Baitboat**
1987	4,200	5,200	3,500
1988	6,800	4,600	4,000
1989	10,000	4,400	3,000
1990	13,800	3,900	1,000
1991	19,600	5,100	2,100
1992	21,100	4,400	1,700
1993	25,300	4,700	2,000
1994	**18,400**	**5,100**	**1,000**
Mean ±SD	14,900 ±6,949	4,675 ±418	2,287 ±1,042

Source and Calculation: Landings data were collected by the NMFS and HDAR. See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Longline landings decreased by 27% in 1994. Troll and handline landings increased 8% from 1993 and were near the 1987-94 average. Baitboat landings decreased 50%, and was significantly lower than the long-term average.

Figure 4. Hawaii non-tuna commercial PPMUS landings by gear type.

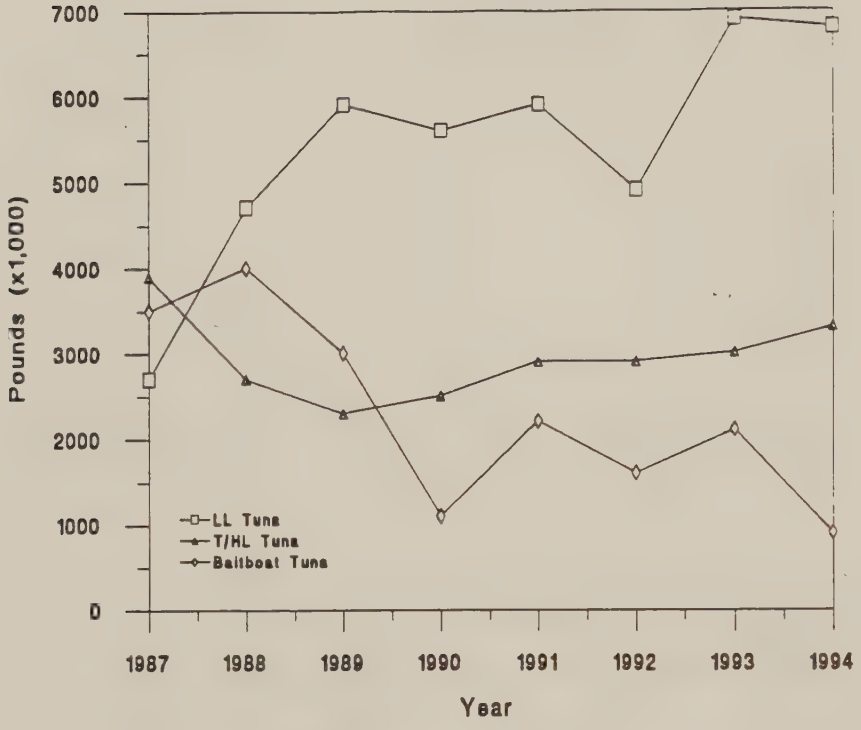


Year	Pounds Landed (x 1,000) Longline	Troll & Handline
1987	900	1,800
1988	1,700	1,500
1989	3,600	1,600
1990	6,800	1,600
1991	13,200	2,100
1992	15,900	1,500
1993	19,100	1,600
1994	**11,600**	**1,600**
Average	9,100 ±6,392	1,662 ±187

Source and Calculation: Landings data were collected by the NMFS and HDAR market monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 pounds. The numbers may not add precisely due to rounding.

Interpretation: Longline landings of non-tuna PPMUS decreased 39%, while troll and handline landings remained about the same and near the long-term average. A decline in swordfish landings contributed most to the decrease in longline landings.

Figure 5. Hawaii commercial tuna landings by gear type.

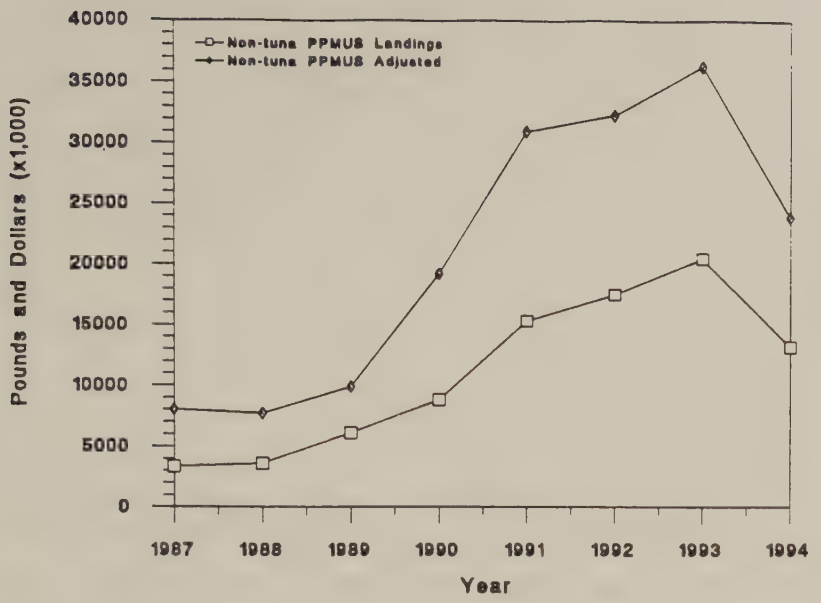


Year	Pounds Landed (x 1,000)		
	Longline	Baitboat	Troll & Handline
1987	2,700	3,600	3,900
1988	4,700	4,300	2,700
1989	5,900	2,800	2,300
1990	5,600	1,000	2,500
1991	5,900	2,200	2,900
1992	4,900	1,500	2,900
1993	6,900	2,100	3,000
1994	**6,800**	**900**	**3,300**
Mean ±SD	5,425 ±1,264	2,300 ±1,134	2,938 ±464

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 pounds. The numbers may not add precisely due to rounding.

Interpretation: Longline landings of tuna reached a record high in 1993 and remained about the same in 1994. Baitboat landings dropped by 57%, while troll and handline landings increased by 10%.

Figure 6. Hawaii non-tuna PPMUS landings and revenue.

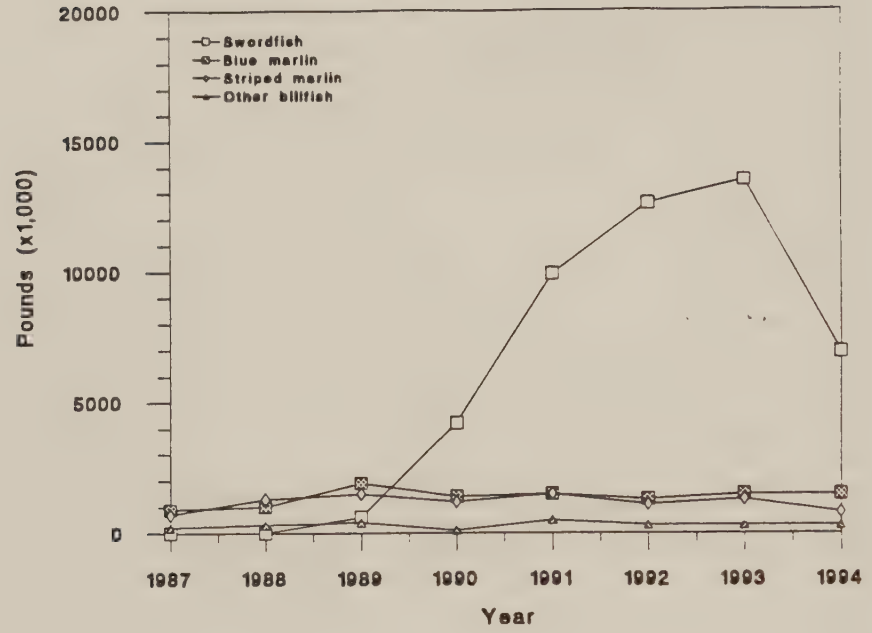


Year	Pounds (x 1,000)	Revenue (x $1,000) Nominal	Adjusted
1987	3,300	5,700	8,000
1988	3,600	5,800	7,700
1989	6,100	7,900	9,900
1990	8,800	16,400	19,200
1991	15,300	28,100	31,000
1992	17,500	30,700	32,300
1993	20,500	35,400	36,300
1994	**13,200**	**23,900**	**23,900**
Mean	11,038 ±6,111	19,238 ±11,143	20,038 ±10,854

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Total non-tuna PPMUS landings decreased substantially (-36%), as did nominal revenue (-32%) and adjusted revenue (-34%). All 1994 figures were near the 1987-94 averages.

Figure 7. Species composition of Hawaii commercial billfish landings.

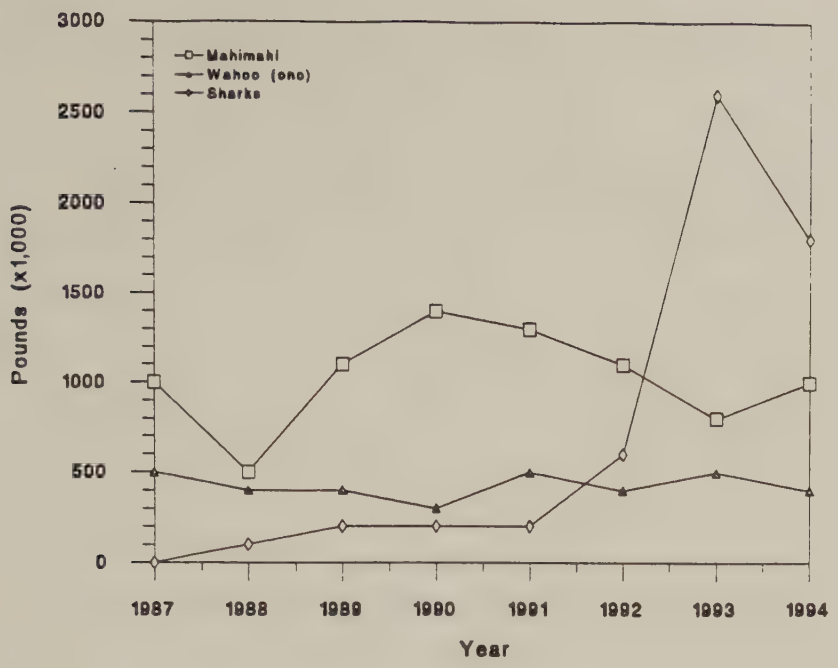


Year	Pounds Landed (x 1,000)			
	Swordfish	Blue marlin	Striped marlin	Other billfish
1987	0	900	700	200
1988	0	1,000	1,300	300
1989	600	1,900	1,500	400
1990	4,200	1,400	1,200	100
1991	9,900	1,500	1,500	500
1992	12,600	1,300	1,100	300
1993	13,500	1,500	1,300	300
1994	**6,900**	**1,500**	**800**	**300**
Mean ±SD	5,963 ±5,247	1,375 ±295	1,175 ±277	300 ±112

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Swordfish landings dropped 49% from 1993, compared to the steeply increasing trend of swordfish landings from 1989 to 1993. Blue marlin landings remained at about the same level and near the long-term average. Striped marlin landings decreased 38% and was significantly lower than the 1987-94 average. Other billfish landings remained near the 1987-94 average.

Figure 8. Hawaii commercial landings -- mahimahi, wahoo, and sharks.

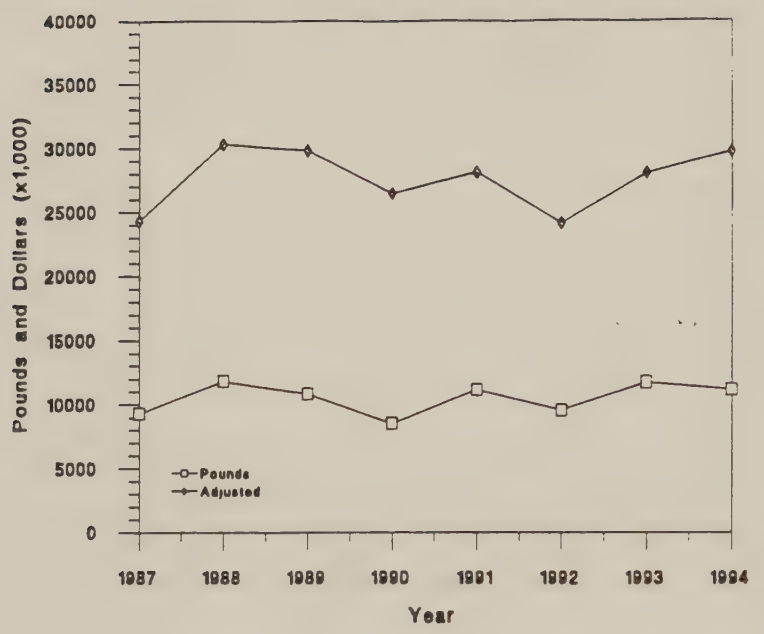


Year	Pounds (x 1,000)		
	Mahimahi	Wahoo	Sharks
1987	1,000	500	0
1988	500	400	100
1989	1,100	400	200
1990	1,400	300	200
1991	1,300	500	200
1992	1,100	400	600
1993	800	500	2,600
1994	**1,000**	**400**	**1,800**
Mean ±SD	1,025 ±263	425 ±66	738 ±950

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Mahimahi landings rose 25% from 1993 and was near the 1987-94 average. Wahoo landings were about the same as 1993, and although shark landings decreased 31% from the peak in 1993, it was still well above the long-term average. The increased shark landings were due to a new estimate of whole weights represented by shark fin landings.

Figure 9. Hawaii tuna landings and revenue.

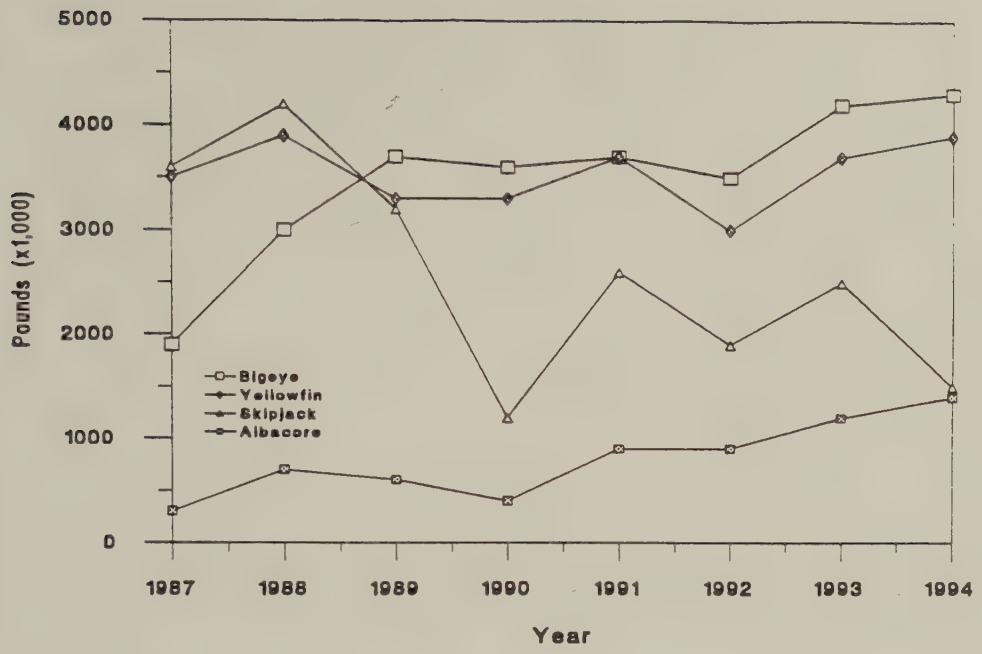


		Revenue (x $1,000)	
Year	Pounds (x 1,000)	Nominal	Adjusted
1987	9,300	17,300	24,300
1988	11,800	22,800	30,300
1989	10,800	23,700	29,800
1990	8,500	22,500	26,400
1991	11,100	25,500	28,100
1992	9,500	22,900	24,100
1993	12,000	27,600	28,000
1994	**11,100**	**29,700**	**29,700**
Mean ±SD	10,475 ±1,139	23,962 ±3,455	27,588 ±2,278

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Total tuna landings decreased 5%, and was near the 1987-94 average. However, nominal (+9%) and adjusted revenue (+6%) increased from the previous year.

Figure 10. Species composition of Hawaii commercial tuna landings.

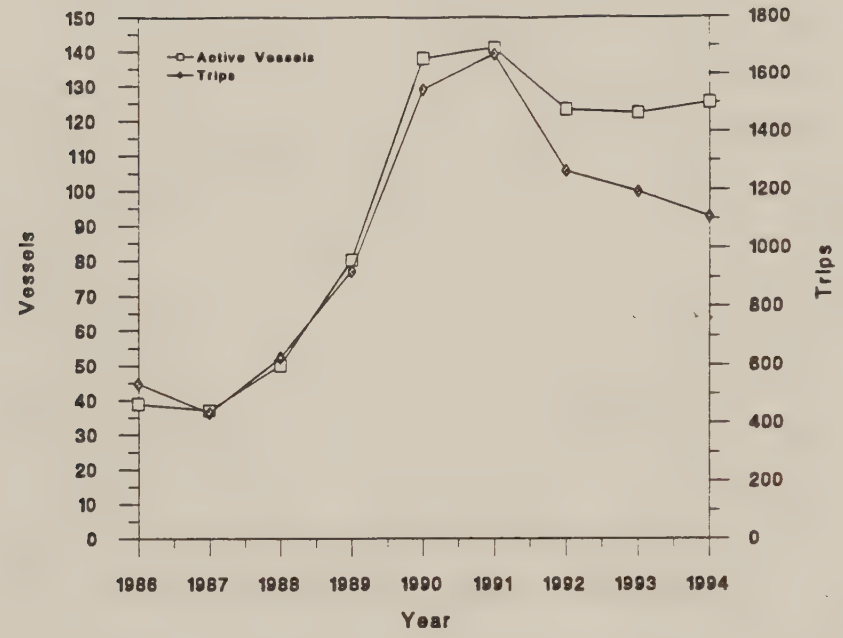


	Pounds Landed (x 1,000)			
Year	Bigeye	Yellowfin	Skipjack	Albacore
1987	1,900	3,500	3,600	300
1988	3,000	3,900	4,200	700
1989	3,700	3,300	3,200	600
1990	3,600	3,300	1,200	400
1991	3,700	3,700	2,600	900
1992	3,500	3,000	1,900	900
1993	4,200	3,900	2,500	1,200
1994	**4,300**	**3,900**	**1,500**	**1,400**
Mean ±SD	3,488 ±710	3,538 ±300	2,588 ±974	800 ±354

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program, and the HDAR commercial catch reporting system (for troll and handline). See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Landings of all species increased from 1993, except for skipjack. Albacore (+17%) reached another new peak. Yellowfin increased 5%, bigeye by 2%, but skipjack decreased by 40%. Yellowfin, bigeye, and albacore landings were higher than the 1987-94 averages, but skipjack was well below average.

Figure 11. Hawaii longline vessel activity.

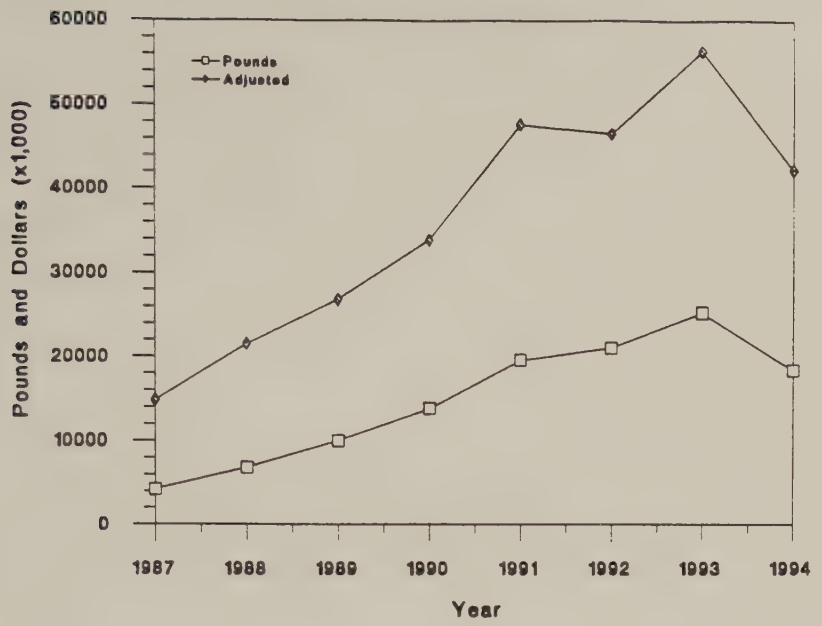


Year	Active Vessels	Trips
1986	39	537
1987	37	435
1988	50	627
1989	80	923
1990	138	1,546
1991	140	1,664
1992	123	1,260
1993	122	1,192
1994	**125**	**1,107**

Source and Calculation: Data were collected by the NMFS longline logbook program and from the NMFS/HDAR shoreside monitoring program. Active vessels were defined as those making at least one longline landing in 1993.

Interpretation: The number of active longline vessels was slightly higher than 1993, but the number of trips decreased by 7%. The decrease in number of trips could be because vessels left Hawaii for various reasons.

Figure 12. Hawaii longline landings and revenue.

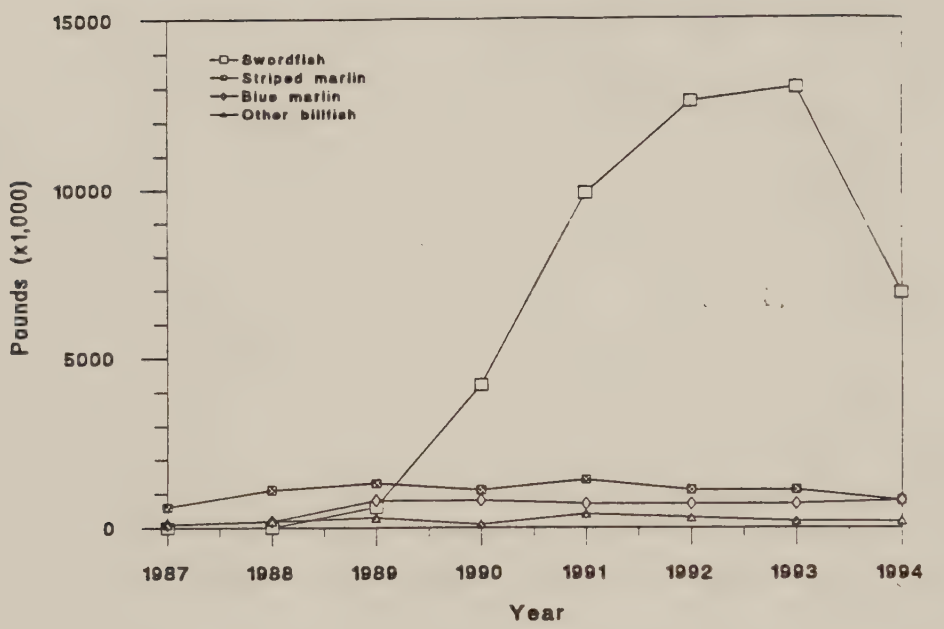


Year	Pounds (x 1,000)	Revenue (x $1,000) Nominal	Adjusted
1987	4,200	10,400	14,800
1988	6,800	16,000	21,500
1989	10,000	21,200	26,800
1990	13,800	28,600	33,900
1991	19,600	43,200	47,700
1992	21,100	44,200	46,600
1993	25,300	55,100	56,400
1994	**18,400**	**42,300**	**42,300**
Mean ±SD	14,900 ±6,949	32,625 ±14,839	36,250 ±13,478

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program and NMFS longline logbook program. See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Longline landings decreased 27% from 1993, compared to the 19% increase from 1992 to 1993. Nominal revenue (-23%) and adjusted revenue (-25%) also decreased substantially.

Figure 13. Hawaii longline landings -- billfish.

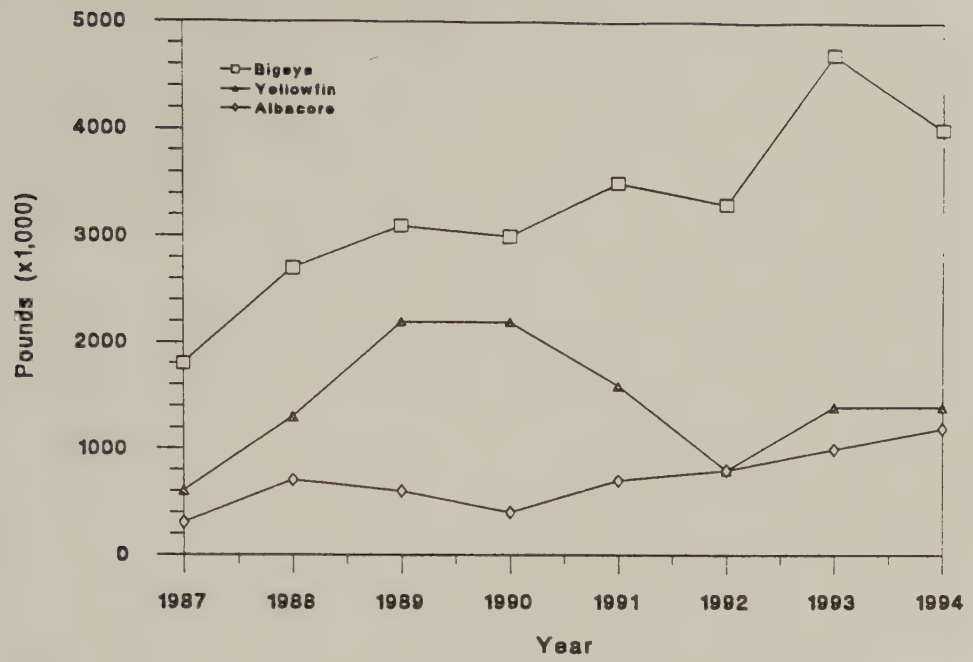


Year	Pounds Landed (x 1,000)			
	Swordfish	Striped marlin	Blue marlin	Other billfish
1987	0	600	100	100
1988	0	1,100	200	200
1989	600	1,300	800	300
1990	4,200	1,100	800	100
1991	9,900	1,400	700	400
1992	12,600	1,100	700	200
1993	13,000	1,100	700	200
1994	**6,900**	**800**	**800**	**200**
Mean ±SD	5,900 ±5,159	1,062 ±239	600 ±265	212 ±93

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program and NMFS longline logbook program. See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Landings of swordfish dropped 47% from 1993, compared to the increasing trend from 1989 to 1993. Blue marlin and other billfish landings showed little change, but striped marlin landings dropped 27%.

Figure 14. Hawaii longline landings -- tunas.

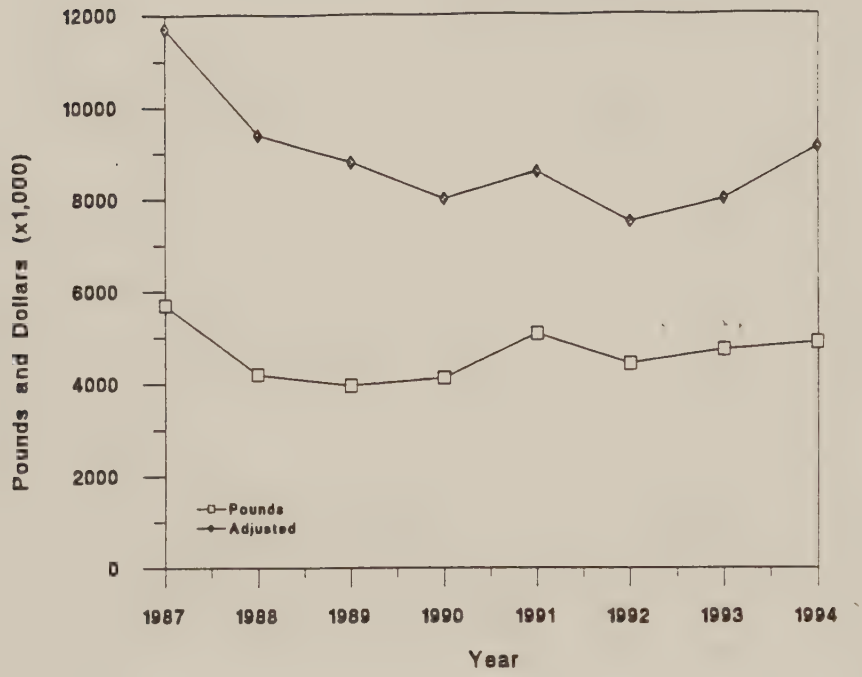


Year	Pounds Landed (x 1,000)		
	Bigeye	Yellowfin	Albacore
1987	1,800	600	300
1988	2,700	1,300	700
1989	3,100	2,200	600
1990	3,000	2,200	400
1991	3,500	1,600	700
1992	3,300	800	800
1993	4,700	1,400	1,000
1994	**4,000**	**1,400**	**1,200**
Mean ±SD	3,262 ±808	1,438 ±538	712 ±276

Source and Calculation: Landings data were collected by the NMFS and HDAR shoreside monitoring program and NMFS longline logbook program. See notes to Table 1 for estimation procedures. Estimates were rounded to the nearest 100,000 lb. The numbers may not add precisely due to rounding.

Interpretation: Longline tuna landings did not change substantially from 1993. Bigeye landings decreased 15%, albacore rose 20%, and yellowfin landings remained about the same.

Figure 15. Hawaii troll and handline landings and revenue.

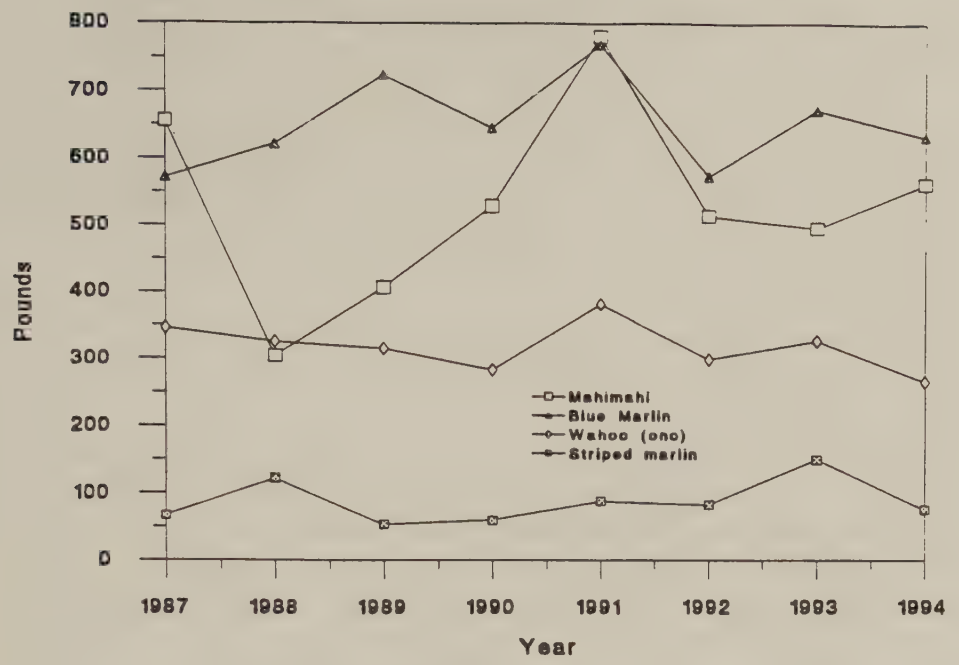


Year	Pounds (x 1,000)	Revenues (x $1,000) Nominal	Adjusted
1987	5,696	8,340	11,700
1988	4,194	7,074	9,400
1989	3,958	7,000	8,800
1990	4,111	6,859	8,000
1991	5,066	7,796	8,600
1992	4,412	7,149	7,500
1993	4,710	7,755	8,000
1994	**4,871**	**9,125**	**9,125**
Mean ±SD	4,628 ±542	7,637 ±734	8,890 ±1,216

Source and Calculation: Landings data were collected by the HDAR commercial catch reporting system. Uncompensated HDAR tabulations are used for troll and handline landings, since these were used for earlier years, and are comparable to previous years' data.

Interpretation: Troll and handline landings (+3%) and adjusted revenue (+14%) increased slightly from 1993 and were not significantly different from the long-term means. Nominal revenue rose 18% and was significantly higher than the long-term mean.

Figure 16. Hawaii commercial troll and handline landings -- non-tuna PPMUS.

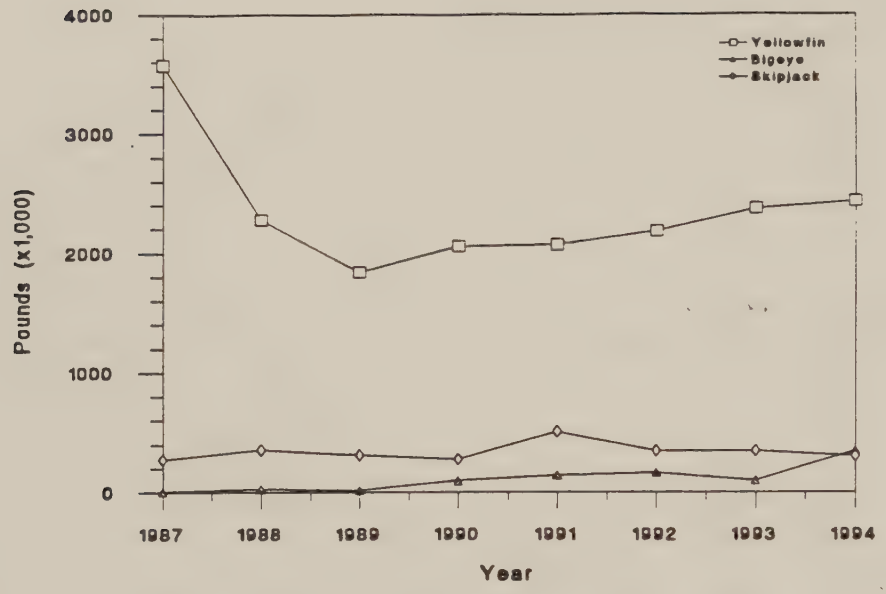


Year	Pounds Landed (x 1,000)			
	Mahimahi	Blue marlin	Wahoo	Striped marlin
1987	655	571	346	66
1988	304	621	326	122
1989	407	724	316	53
1990	529	645	284	59
1991	781	769	383	88
1992	515	574	300	83
1993	497	672	328	151
1994	**562**	**633**	**267**	**76**
Mean ±SD	531 ±136	654 ±64	319 ±34	87 ±31

Source and Calculation: Landings data were collected by the HDAR commercial catch reporting system. Uncompensated HDAR tabulations are used for troll and handline landings, since these were used for earlier years, and are comparable to previous years' data.

Interpretation: Mahimahi landings (+13%) rose but did not reach the peak in 1991. Blue marlin rose by 6%. Wahoo landings decreased 19% and dropped below the long-term average. Striped marlin landings decreased substantially (-50%) and was near the long-term average.

Figure 17. Hawaii commercial troll and handline landings -- tunas.

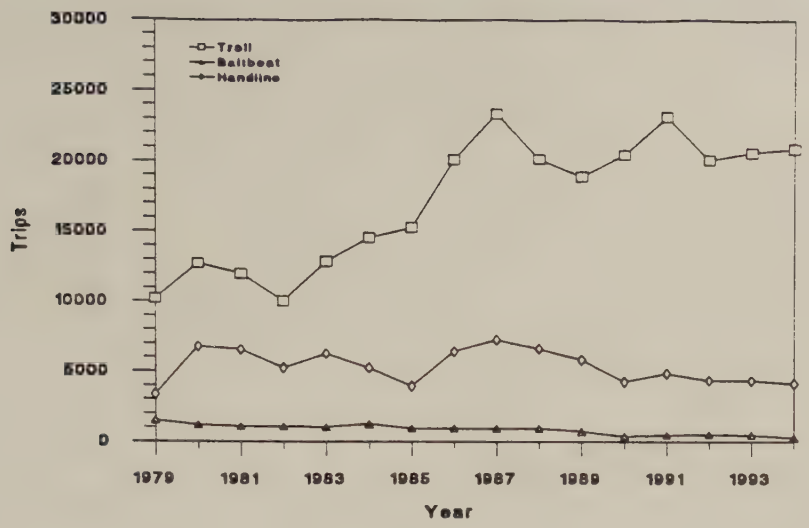


Year	Pounds Landed (x 1,000)		
	Yellowfin	Bigeye	Skipjack
1987	3,575	6	275
1988	2,275	31	355
1989	1,837	19	313
1990	2,054	97	275
1991	2,066	142	504
1992	2,182	164	347
1993	2,367	98	345
1994	**2,426**	**344**	**301**
Mean ±SD	2,348 ±496	113 ±103	339 ±69

Source and Calculation: Landings data were collected by the HDAR commercial catch reporting system. Uncompensated HDAR tabulations are used for troll and handline landings, since these were used for earlier years, and are comparable to previous years' data.

Interpretation: In 1994, troll and handline landings of yellowfin tuna were slightly higher (+2%) than in 1993. Bigeye tuna landings rose an unprecedented 251% from 1993 and reached a new peak in landings. The change may be partly due to improved species discrimination between yellowfin and bigeye tunas. Skipjack landings decreased 13%, and was near the long-term average.

Figure 18. Hawaii commercial pelagic trips by non-longline gear.

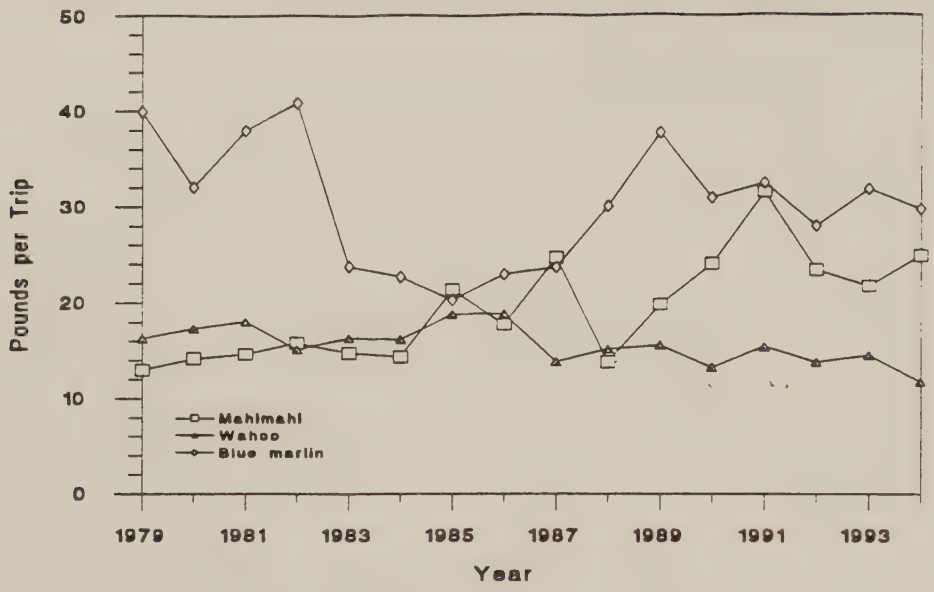


	Number of Trips		
Year	Troll	Baitboat	Handline
1979	10,185	1,495	3,346
1980	12,692	1,149	6,746
1981	11,975	1,059	6,562
1982	10,039	1,067	5,219
1983	12,842	1,014	6,275
1984	14,556	1,232	5,248
1985	15,291	924	3,929
1986	20,139	941	6,412
1987	23,391	938	7,263
1988	20,202	941	6,647
1989	18,924	723	5,834
1990	20,468	378	4,261
1991	23,184	463	4,861
1992	20,109	510	4,374
1993	20,647	477	4,343
1994	**20,905**	**281**	**4,142**
Mean ±SD	17,222 ±4,453	850 ±332	5,341 ±1,170

Source and Calculation: Division of Aquatic Resources's Commercial Catch Reports for calendar years. Each day fished for a pelagic species by a fisherman is one trip, that is, daily trips were assumed. All handline gear trips were combined into the handline trip total. Total handline trips may be inaccurate for recent years due to multi-day trips taken by fishermen working offshore seamounts or weather buoys. Unsuccessful (no-catch) trips were not included; such data generally have not been reported by fishermen and were not processed prior to 1989.

Interpretation: Reported trolling trips have doubled since 1979, with a rapid increase in the mid-1980s. However, the number has changed relatively little from 1986 on, averaging 20,885 ±1,385 (1986-94). Baitboat trips have decreased by 81% from 1979, beginning at the time the Honolulu tuna cannery closed in 1984. Combined handline trips show no particular trend, with peaks in 1980, 1983, and 1987, but was significantly below the long-term average in 1994.

Figure 19. Commercial trolling catch per trip -- mahimahi, wahoo and blue marlin.

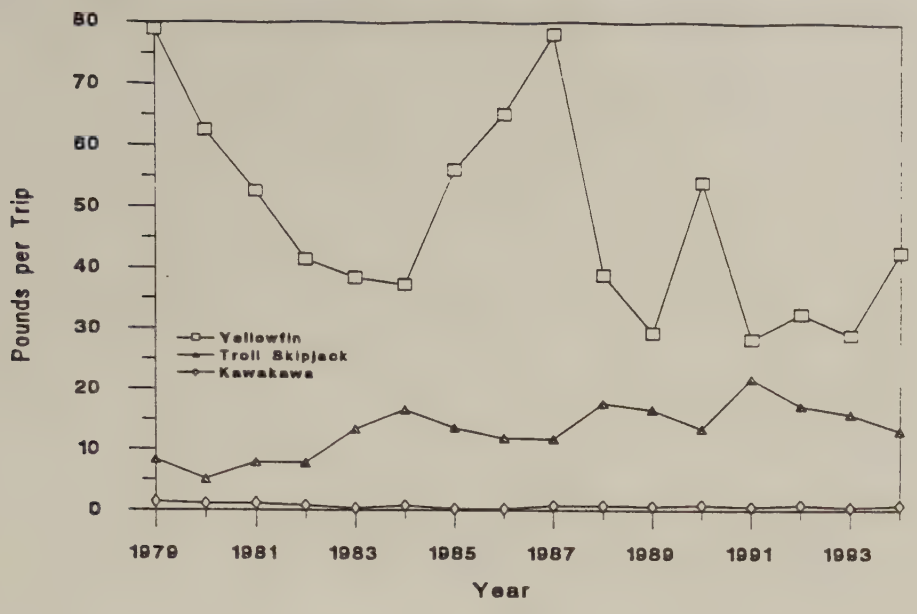


	Pounds Caught per Trolling Trip		
Year	Mahimahi	Wahoo	Blue Marlin
1979	13.0	16.3	39.9
1980	14.2	17.3	32.0
1981	14.6	18.0	37.9
1982	15.8	15.1	40.8
1983	14.7	16.3	23.8
1984	14.3	16.1	22.7
1985	21.3	18.8	20.3
1986	17.7	18.8	22.9
1987	24.7	13.8	23.7
1988	13.8	15.1	30.1
1989	19.8	15.6	37.7
1990	24.0	13.2	30.9
1991	31.5	15.4	32.5
1992	23.4	13.7	28.0
1993	21.6	14.5	31.8
1994	24.9	11.7	29.7
Mean ±SD	19.3 ±5.2	15.6 ±1.9	30.3 ±6.3

Source and Calculation: Division of Aquatic Resources's Commercial Catch Reports for calendar years. Estimated catch per trip (CPT) was calculated by dividing the annual troll landings of each major species by the annual number of troll trips that caught any PPMUS. Daily trips were assumed. Unsuccessful (no-catch) trips were not included; such data generally have not been reported by fishermen and were not processed prior to 1989.

Interpretation: Mahimahi CPT rose 15% from 1993 and was significantly higher than the long-term average. The wahoo CPT decreased 19% from 1993 and was below the long-term average. Blue marlin CPT showed a broad depression from 1983 to 1987, but rose rapidly in 1989 to pre-1983 levels. The CPT dropped in 1990-94 and was within the long-term average, but remained higher than in 1983-87.

Figure 20. Commercial trolling catch per trip -- yellowfin, skipjack and kawakawa.

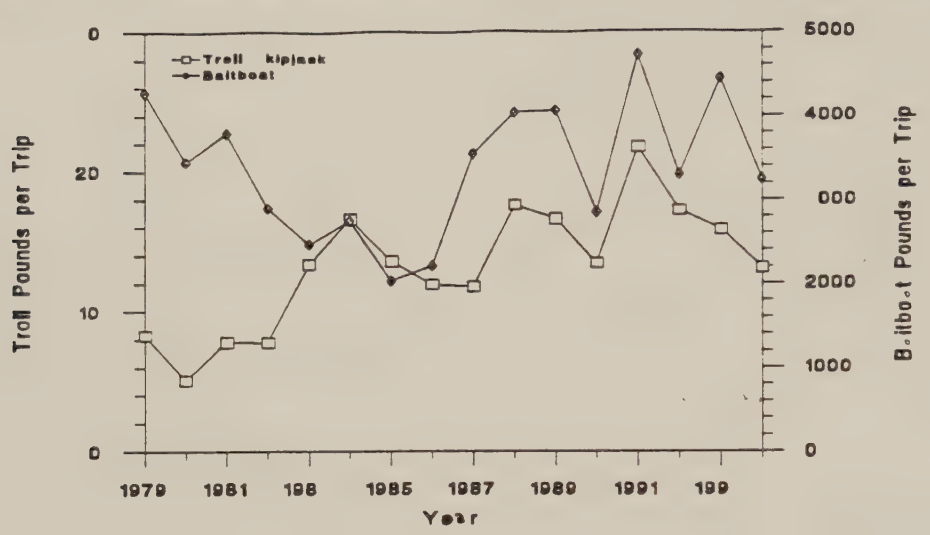


	Pounds Caught per Trolling Trip		
Year	Yellowfin	Skipjack	Kawakawa
1979	79.0	8.3	1.4
1980	62.5	5.1	1.0
1981	52.5	7.8	1.1
1982	41.3	7.8	0.7
1983	38.3	13.4	0.3
1984	37.2	16.6	0.8
1985	55.9	13.6	0.3
1986	65.1	11.9	0.3
1987	78.1	11.8	0.8
1988	38.7	17.6	0.8
1989	29.2	16.6	0.7
1990	53.9	13.4	0.8
1991	28.2	21.7	0.5
1992	32.3	17.2	0.8
1993	28.9	15.8	0.4
1994	**42.4**	**13.1**	**0.8**
Mean ±SD	47.7 ±16.2	13.2 ±4.3	0.7 ±0.3

Source and Calculation: Division of Aquatic Resources's Commercial Catch Reports for calendar years. Estimated catch per trip (CPT) was calculated by dividing the annual troll landings of each major species by the annual number of troll trips that caught any PPMUS. Daily trips were assumed. Unsuccessful (no-catch) trips were not included; such data generally have not been reported by fishermen and were not processed prior to 1989.

Interpretation: Yellowfin CPT has fluctuated widely. The 1994 CPT rose 47% from 1993 but remained within the long-term average. Skipjack CPT had shown a generally rising trend for the entire period, but the 1994 CPT declined 17% from 1993 and was on the long-term average. Kawakawa CPT rose 100% but remains near the long-term average. It exhibits high relative fluctuations, but is so low overall that these fluctuations may be insignificant.

Figure 21. Commercial trolling and baitboat catch per trip -- skipjack tuna.

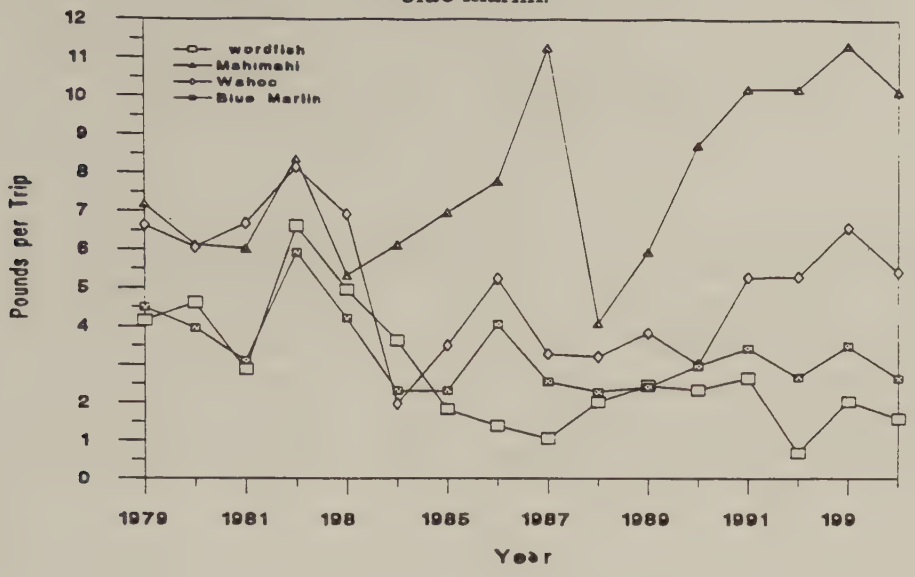


	Pounds Skipjack Caught	
Year	Troll	Baitboat
1979	8.3	4,278
1980	5.1	3,447
1981	7.8	3,786
1982	7.8	2,892
1983	13.4	2,468
1984	16.6	2,748
1985	13.6	2,031
1986	11.9	2,206
1987	11.8	3,548
1988	17.6	4,036
1989	16.6	4,061
1990	13.4	2,840
1991	21.7	4,722
1992	17.2	3,297
1993	15.8	4,447
1994	**13.1**	**3,240**
Mean ±SD	13.2 ±4.3	3,378 ±784

Source and Calculation: Division of Aquatic Resources Commercial Catch Reports for calendar years. Estimated catch per trip (CPT) was calculated by dividing the annual troll or baitboat landings of each major species by the annual number of troll or baitboat trips that caught any PPMUS. Daily trips were assumed. Unsuccessful (no-catch) trips were not included; such data generally have not been reported by fishermen and were not processed prior to 1989. Troll skipjack data do not include skipjack used as live bait.

Interpretation: There was a broad depression in baitboat catch per trip during the early 1980s, a dip in 1990, but a record high in 1991. The 1994 CPT dropped back to the long-term average from a peak in 1993. Troll CPT also reached a record high in 1991 and dropped back to the average in 1994. The similarity in trends between troll and baitboat CPTs from 1986 on may be due to the dramatically reduced baitboat fleet working mainly around Oahu, where most of the trolling fleet is located. However, in 1993, while baitboat CPT rose, troll CPT fell. Both CPTs fell in 1994.

Figure 22. Combined commercial handline catch per trip -- swordfish, mahimahi, wahoo, and blue marlin.

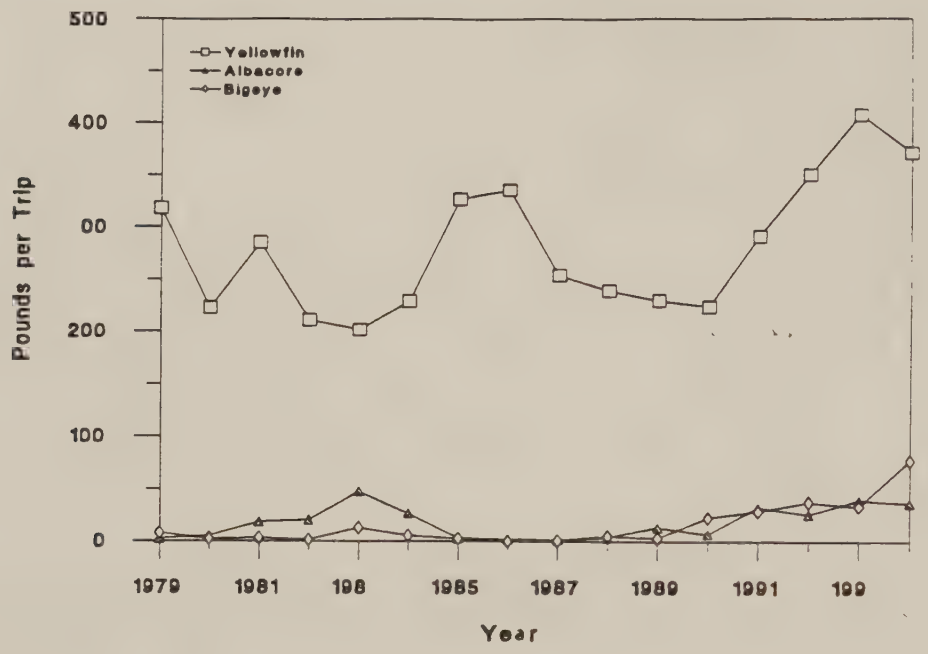


	Combined Handline Catch per Trip (lb)			
Year	Swordfish	Mahimahi	Wahoo	Blue Marlin
1979	4.1	7.2	6.6	4.5
1980	4.6	6.1	6.0	4.0
1981	2.9	6.0	6.7	3.1
1982	6.6	8.4	8.1	5.9
1983	5.0	5.3	6.9	4.2
1984	3.6	6.1	2.0	2.3
1985	1.8	7.0	3.5	2.3
1986	1.4	7.8	5.2	4.1
1987	1.1	11.3	3.3	2.5
1988	2.0	4.1	3.2	2.3
1989	2.4	6.0	3.8	2.4
1990	2.3	8.7	3.0	3.0
1991	2.7	10.2	5.3	3.4
1992	0.7	10.2	5.3	2.7
1993	2.0	11.4	6.6	3.5
1994	1.6	10.1	5.4	2.7
Mean ±SD	2.8 ±1.5	7.9 ±2.2	5.1 ±1.7	3.3 ±1.0

Source and Calculation: Division of Aquatic Resources's Commercial Catch Reports for calendar years. Estimated catch per trip (CPT) calculated by dividing the annual handline landings of each major species by the annual number of handline trips that caught any PPMUS. Daily trips were assumed. Unsuccessful (no-catch) trips were not included; such data generally have not been reported by fishermen and were not processed prior to 1989. Only major non-tuna PPMUS caught by handline are shown here.

Interpretation: Except for swordfish, the major handline non-tuna PPMUS show peaks in CPT in 1982 and in 1986 or 1987. Mahimahi CPT rose to a peak in 1987, dropped to a new low in 1988, then rose to a new record peak in 1993. The high mahimahi CPT continued for 1994. The CPTs for swordfish, wahoo, and blue marlin decreased from 1993, but remained near the long-term average.

Figure 23. Combined commercial handline catch per trip -- yellowfin, albacore and bigeye tunas.



Year	Combined Handline Catch per Trip (lb)		
	Yellowfin	Albacore	Bigeye
1979	318.1	2.6	7.8
1980	222.4	5.0	2.3
1981	284.5	18.6	3.3
1982	210.5	20.5	1.6
1983	201.2	47.6	13.1
1984	228.6	26.7	5.6
1985	326.0	3.1	2.6
1986	334.9	1.8	0.4
1987	252.9	1.8	0.9
1988	238.4	3.7	4.9
1989	229.2	13.4	3.3
1990	223.2	7.0	22.7
1991	290.8	32.3	29.2
1992	350.2	25.8	37.5
1993	407.7	35.1	21.1
1994	**363.9**	**36.6**	**76.7**
Mean ±SD	280.2 ±61.4	17.6 ±14.5	14.6 ±19.4

Source and Calculation: Division of Aquatic Resources's Commercial Catch Reports for calendar years. Estimated catch per trip (CPT) calculated by dividing the annual handline landings of each major species by the annual number of handline trips that caught any PPMUS. Daily trips

were assumed. Unsuccessful (no-catch) trips were not included; such data generally have not been reported by fishermen and were not processed prior to 1989. Only major tuna species caught by handline are shown here. Bigeye catch per trip may have errors due to reporting of bigeye as "bluefin" or yellowfin tuna, but due to the relative volume of landings, the resulting errors in the yellowfin statistics are probably small.

Interpretation: From 1981-83, landings of albacore and bigeye tuna increased while yellowfin was depressed, and then in 1985-86 were low when yellowfin peaked. Yellowfin CPT declined through 1990, and then increased rapidly. In 1993, yellowfin CPT rose to a record peak. The 1994 CPT decreased 11% but was still second only to 1993. Albacore CPT remained relatively high and significantly above the long-term average. The 1994 bigeye CPT hit a record peak, more than double the nearest high in 1992, and 3.6 times 1993's CPT. The recent rise in bigeye CPT may due to the contribution of handline fishermen fishing around weather buoys and offshore seamounts.

Appendix 4

Commonwealth of the Northern Mariana Islands

Introduction

The Northern Mariana Islands pelagic fishery occurs primarily around the islands of Saipan, Tinian, Rota and Aguigan. The fishery is characterized using data in the Commercial Purchase Data Base. The collection system for the data is dependent upon first-level purchasers of local fresh fish to accurately record all fish purchases by species categories on specially designed invoices. Staff from the Department of Lands and Natural Resources, Division of Fish and Wildlife (DFW) routinely distribute and collect invoice books from 46 participating local fish purchasers on Saipan. Purchasers include practically all fish markets, stores, restaurants, hotels and roadside vendors ("fish-mobiles"). Data collection commenced on Rota during March 1993 and on Tinian during August 1993, making 1994 the second year that Tinian and Rota were included in the Commercial Purchase data collection system. This data set includes fourteen participating vendors on Rota and five on Tinian. Existing software programs are still in need of revision for data entry and analysis functions.

Although the Saipan data collection system has been in operation since the mid-1970s, only data collected since 1983 are considered accurate enough to be used. Data quality, with respect to accuracy of landings and species identification on the invoice, needs to be investigated and verified; conclusions reached in this report should be considered provisional. Fortunately, the most complete data were obtained from the larger operations, so general landings trends, while underestimated, are believed to be relatively accurate.

This database lacks information concerning fishing method, location and effort, though the Offshore Port Sampling Survey could provide the additional data required for further analysis. Although the NMFS Honolulu Lab is assisting the NMI with computer programs to estimate total landings and effort by method, the results aren't yet ready for this report.

To fish commercially within the NMI's exclusive economic zone (EEZ), commercial vessels over five net tons must have a Commercial Fishing License, issued annually and jointly by the Department of Commerce & Labor and the Department of Natural Resources. Depending on the information supplied in the application package, the DFW may impose certain fishing restrictions in the form of license conditions. Although commercial boats under five net tons needn't have a fishing license to operate, all fishing boats are registered with the Department of Public Safety, which contributed to the information below.

Summary

Trolling is the primary fishing method utilized in the pelagic fishery. The pelagic fishing fleet, other than charterboats, consists primarily of vessels less than 24 ft in length which usually have a

limited 20-mile travel radius from Saipan. In 1994, about 69% of all registered boats participated in some form of fishing activity. There were 109 vessels identified as being involved full-time in commercial fishing, whereas 78 vessels were classified as part-time. Of these 187 fishing boats, 66 were identified as having landed any pelagic catch. Subsistence fishing and/or recreational usage included 273 vessels (for all kinds of fish). Pelagic fishing trips are generally restricted to daylight hours.

In 1994, 36 vessels were registered with the Boating Safety Office as charter vessels, although only six vessels conduct full-time charter fishing operations. The remaining 30 charter vessels are associated with part-time fishing and the tourist transport industry. Each charter vessel generally retains its catch and sells at least half to local markets. The magnitude of charterboat sales are unknown, but at this time it is questionable whether the local market can absorb the catch without impacting commercial fishermen. The logbook system used in 1993 was not continued in 1994 due to lack of personnel, but it is planned to begin again in 1995.

The primary target species for the pelagic fleet remain skipjack tuna and mahimahi. During their seasonal runs, these fish usually inundate nearshore waters and provide easy targets for the local fishermen. In addition to the economic advantage of being nearshore and their relative ease of capture, these two species are widely accepted by all ethnic groups. This has kept market demand fairly high due to the continuing immigrant population growth on Saipan (about half of the population on Saipan is non-native).

The use of larger vessels (>50 ft) for pelagic fishing remains limited. Four commercial fishing licenses were issued in 1994, two each in 1993 and 1992, and none in 1991. In 1994 no licensed vessels fished the full 12 months, and none directed it's efforts entirely at a pelagic fishery, although pelagic fish comprised an incidental catch on two boats. Fisheries development by foreign vessels may still be impeded by US regulations. Inquiries from potential investors in Indonesia, the Peoples Republic of China and Hong Kong may have been stifled when Coast Guard vessel documentation requirements were discussed (documentation procedures require commercial fishing vessels over five net tons to be majority-owned by US citizens).

Recommendations

1) An examination of the entry/exit patterns of commercial fishermen should be completed for at least the past four years to determine the industry's participation thresholds (see Fig. 4).

2) A careful review and comparison of length frequencies and regional landings should be conducted to obtain general biological characteristics from the fishery.

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Table 1. NMI 1994 commercial pelagic landings, revenues and price

Species	Landings (lb)	Revenue ($)	Ave. Price ($/lb)
Misc. tunas	228	430	1.88
Skipjack tuna	73,769	125,390	1.70
Yellowfin tuna	10,600	22,120	2.09
Subtotal Above Tunas	**84,597**	**147,940**	**1.75**
Dogtooth tuna	5,432	11,422	2.10
Mahimahi	11,993	21,404	1.78
Marlin	2,108	2,432	1.15
Sailfish	77	108	1.40
Wahoo	3,090	6,182	2.00
Subtotal Other PPMUS	**22,700**	**41,548**	**1.78**
Troll fish	9,730	16,367	1.68
Rainbow runner	638	1,269	1.99
Subtotal Misc.	**10,368**	**17,636**	**2.00**
All Pelagics	**117,665**	**190,757**	**1.83**

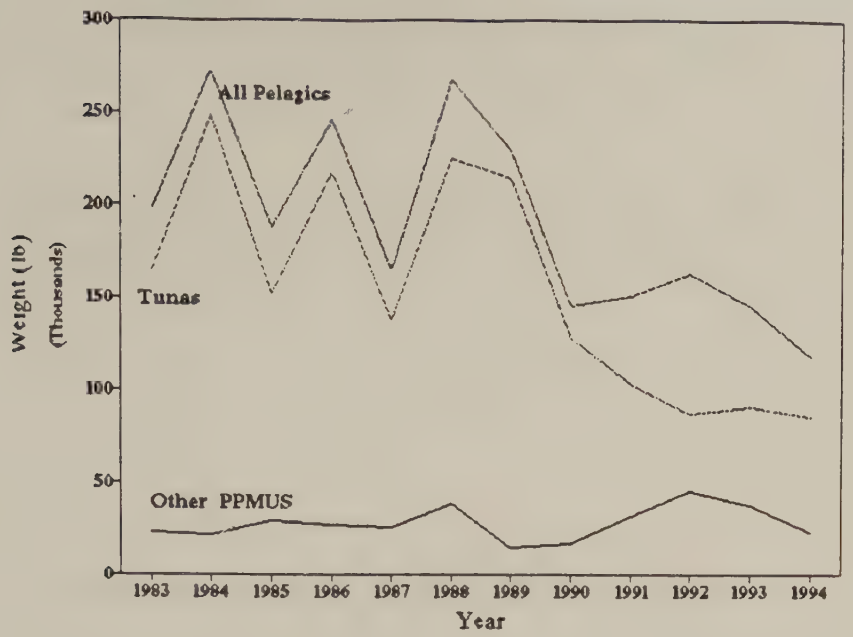
Source and Calculation: Annual summaries for each species from the Commercial Purchase Data Base invoices.

Interpretation: Skipjack catch continued its decline into 1994 although it still comprised about two thirds of the (commercially receipted) industry's pelagic catch. Mahimahi and yellowfin tuna were still ranked second and third in total landings during 1994, at about 10% and 9% of the total catch, respectively. Schools of mahimahi, like skipjack tuna, are easily caught in nearshore waters, especially in the vicinity of the NMI's several FADs. Mahimahi are highly seasonal, usually peaking during March and April.

The highest average price of identified pelagic species was $2.10/lb for dogtooth tuna, which is a change from the previous year when the highest price was commanded by sailfish (due to a paucity of records for the latter species). The lowest priced species remains marlin at $1.15/lb. The market share of total pelagic revenues by combined yellowfin tuna and mahimahi increased from 30% in 1993, to 37% in 1994. Historically, as well as during 1994, yellowfin tuna commanded the best price as it is the species of choice with the restaurant industry. Skipjack tuna, the species with the greatest landings, received only $1.70/lb on average yet it was still responsible for close to two thirds of the total pelagic revenues for 1994.

Blue marlin, which brought the lowest average price, is taken primarily by charterboat fishermen. Other recreational fishermen also take it during scheduled fishing tournaments. Although not generally regarded as an excellent eating fish, marlin sashimi is sold in local restaurants and hotels and is being served in public institutions. The low ex-vessel price could be partly related to the manner which the fish is kept prior to sale and the bulky size. These large fish (relative to the other pelagic species caught) are generally not iced when caught and, therefore, are usually of lower quality at the time of sale. Fishermen usually wish to sell the whole fish to avoid cleaning and repackaging the fish into smaller units for sale to restaurants.

Figure 1. NMI annual commercial landings: all pelagics, tuna and PPMUS.

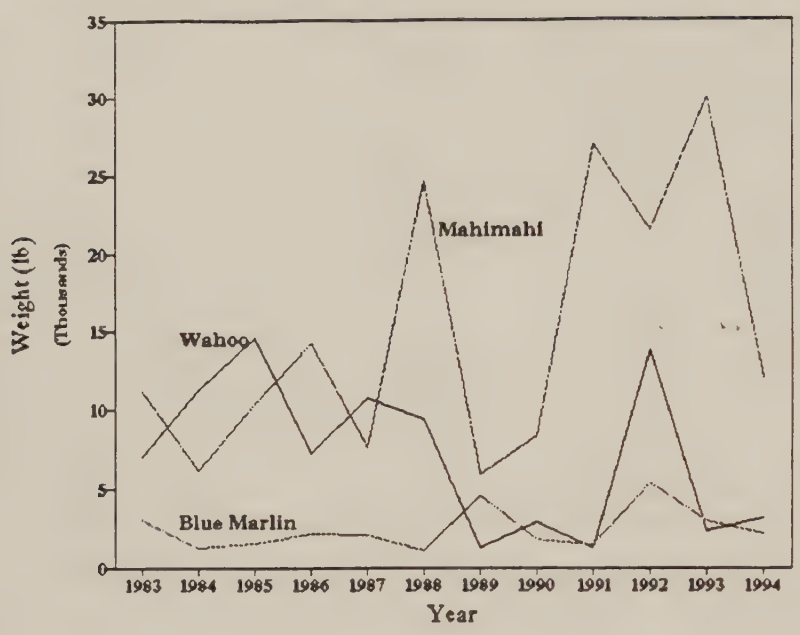


	Total Landings (lb)		
Year	All Pelagics	Tunas	Other PPMUS
1983	196,788	163,754	23,081
1984	272,909	248,339	21,223
1985	187,378	151,882	29,105
1986	245,967	217,023	26,800
1987	164,055	137,566	25,467
1988	267,619	225,498	38,368
1989	229,427	214,249	14,650
1983	144,862	127,172	16,893
1991	150,915	103,078	31,300
1992	162,691	86,931	45,061
1993	145,115	90,584	37,628
1994	**117,668**	**84,598**	**22,701**
AVERAGE	190,450	154,223	27,690

Source and Calculation: All pelagics, tuna and other PPMUS landings were summed from the Commercial Purchase Data Base.

Interpretation: Total weight of pelagics caught in 1994 was at its lowest in the twelve year recorded history. Recorded landings of tunas were about half of what they were a decade ago, which follows a general trend of decline in the last five years. Catch of fish in the "Other PPMUS" category was about 20% lower than average. That the recent increase in imported high-quality yellowfin tuna may have reduced the market demand for a domestically-caught product.

Figure 2. NMI annual commercial landings: mahimahi, wahoo, and marlin.



Total Commercial Landings (lb)

Year	Mahimahi	Wahoo	Blue Marlin
1983	11,151	7,008	3,030
1984	6,091	11,270	1,235
1983	10,364	14,601	1,488
1986	14,237	7,250	2,123
1987	7,602	10,723	1,968
1988	24,639	9,358	1,047
1989	5,856	1,257	4,563
1990	8,306	2,770	1,748
1991	27,005	1,217	1,320
1992	21,462	13,738	5,345
1993	30,036	2,257	2,950
1994	**11,993**	**3,090**	**2,108**
AVERAGE	14,895	7,045	2,410

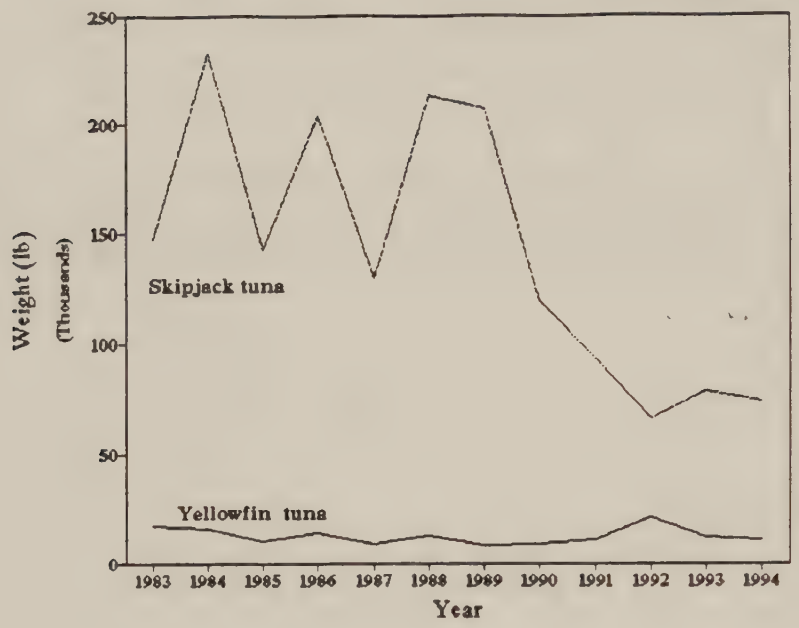
Source and Calculation: The annual commercial landings of the three major PPMUS species (mahimahi, wahoo and blue marlin) were summed directly from the Commercial Purchase Data Base.

Interpretation: Mahimahi landings plummeted in 1994 to one-third of the previous year's record high, and only about 72% of the mean for the decade. It was also considerably lower than the last three year's catch. It is noteworthy that NMI and Guam mahimahi catch have fluctuated similarly since about 1987, which may indicate a strong biological influence in local landings patterns.

From 1983 to 1988, wahoo landings were somewhat consistent and did not fall below 7,000 lb, but in 1989 landings notably declined by 86% and remained at depressed levels until the dramatic increase in landings during 1992. Following the near-record 1992 landings, the 1993 wahoo landings again decreased by 84%, falling below the mean. 1994 saw a rise from the previous year by more than a third. The landings pattern remains largely unexplained.

Blue marlin landings have historically remained at levels less than 3,000 lb with the exception of the 1992 and 1989. If we consider one or both of these points as outliers in the twelve year tabled history (above), 1994's catch is within 10% of the average for the remaining values.

Figure 3. NMI annual commercial landings: skipjack and yellowfin tuna.



	Total Commercial Landings (lb)	
Year	Skipjack tuna	Yellowfin tuna
1983	146,729	17,025
1984	232,675	15,664
1985	141,910	9,973
1986	203,490	13,533
1987	129,203	8,363
1988	213,198	12,300
1989	206,162	8,087
1990	118,798	8,374
1991	92,642	10,433
1992	65,982	20,672
1993	77,832	11,919
1994	**73,769**	**10,600**
AVERAGE	141,866	12,245

Source and Calculation: Landings were summed directly from the Commercial Purchase Data Base.

Interpretation: Historically, skipjack landings exhibited an alternating two-year cycle from 1983 to 1988 and comprised over 73% by weight of the total pelagic landings each year from 1983 to 1989 (data taken from Table 1 and Fig. 3). Skipjack tuna landings declined after that, setting record lows in 1990, 1991 and 1992. In 1993 and 1994 skipjack landings showed signs of stabilizing at about half of their respective eleven and twelve year means.

Schools of skipjack tuna have historically been ubiquitous in nearshore waters, thus providing an opportunity to catch numerous fish with a minimum of travel time and fuel costs. Unlike Guam, skipjack tuna are readily consumed and even prized by the indigenous population. Although it is believed that the highliners are moving away from the fishing industry and, thus, causing the general downturn in skipjack landings, biological reasons should not be eliminated at this time.

In Saipan waters, yellowfin tuna are not often taken, and the average fish size tends to be smaller when compared with yellowfin tuna from other geographic areas. The 1994 landings declined by 11% from 1993 (which is similar to that of skipjack) and remained 13% below the twelve year average.

Figure 4. Number of NMI fishermen (boats) making commercial pelagic landings.

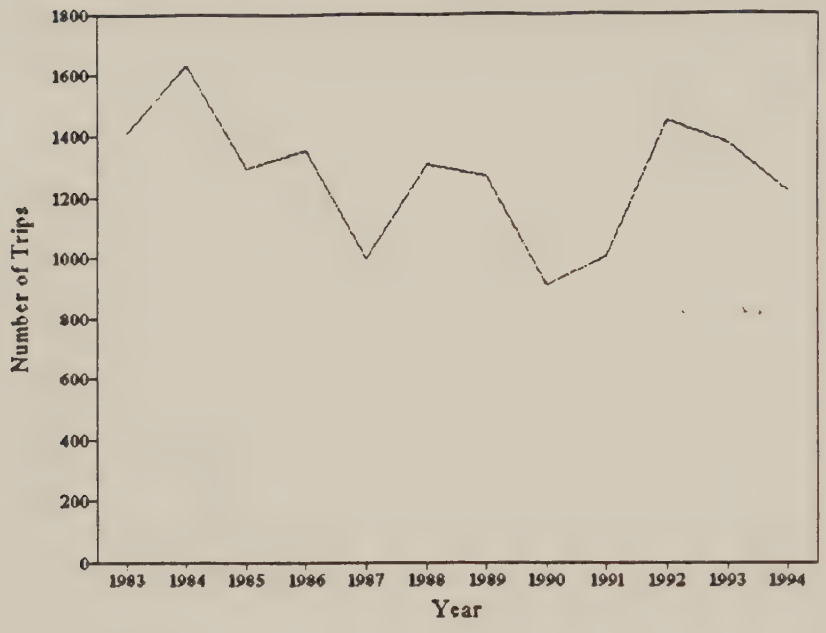
Year	No. fishermen landing any pelagic species
1983	92
1984	97
1985	75
1986	96
1987	60
1988	77
1989	77
1990	77
1991	74
1992	105
1993	54
1994	**66**
AVERAGE	79

Source and Calculation: Each invoice from the Commercial Purchase Data Base records the fisherman's name from whom the fish were purchased. The number of fishermen who sold any pelagic species was calculated directly from the data invoices.

Interpretation: The number of fishermen (boats) making commercial pelagic landings was relatively constant from 1988-91 compared to earlier years, but a record high number was recorded for 1992 (+42% from 1991). Some of the increase in 1992 was attributable to the influx of new fishing boats as a result of money obtained by leasing property. In addition, it was discovered that some fishermen were using several different boats, thus artificially inflating the total number of boats making pelagic landings.

Many of 1992's "new" fishermen, with their new boats, are believed to have left the fishery during 1993. The number of fishermen in 1994 showed a mild recovery from 1993, probably due to the re-entry of repaired and refurbished boats from the 1992 fleet. A entry/exit pattern of fishermen and boats within the fishery should be completed for the past four years to fully explore this aspect.

Figure 5. NMI number of trips catching any pelagic fish.

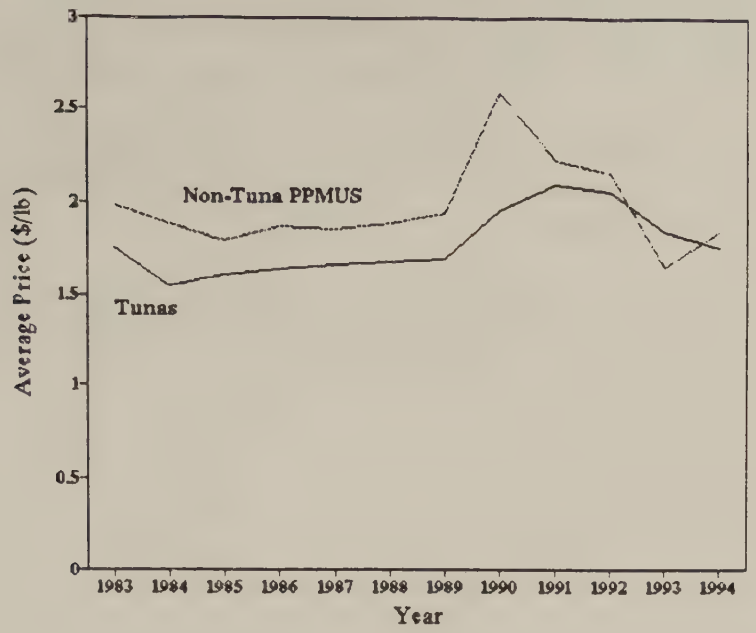


Year	Number trips
1983	1,408
1984	1,634
1985	1,293
1986	1,356
1987	999
1988	1,306
1989	1,272
1990	910
1991	1,002
1992	1,451
1993	1,378
1994	**1,221**
AVERAGE	1,269

Source and Calculation: The total trips for all pelagic species were summed from the Commercial Purchase Data Base. Trips were calculated based on the assumptions that no fisherman makes more than one trip per day, and that all sales from a single trip are made on a single day.

Interpretation: Although the number of pelagic trips continued to decline in 1994, it has remained fairly constant over the twelve year period. It would be expected that the number of pelagic trips would consistently follow the same decline as the number of fishermen landing any pelagic species (Fig. 4), but that was not the situation for the latter six years of tabled data. It is possible that multiple invoices are being submitted for single fishing trips, causing the number of pelagic trips to be inflated. The magnitude of this data problem still needs to be assessed and, if necessary, corrected.

Figure 6. NMI average inflation-adjusted price of tunas and other PPMUS.



	Average Price ($/lb)			
	Tunas		Other PPMUS	
Year	Unadjusted	Adjusted	Unadjusted	Adjusted
1983	0.99	1.75	1.12	1.98
1984	0.95	1.54	1.15	1.88
1985	1.02	1.60	1.14	1.79
1986	1.07	1.63	1.22	1.86
1987	1.14	1.66	1.27	1.85
1988	1.20	1.67	1.35	1.88
1989	1.29	1.69	1.48	1.93
1990	1.56	1.95	2.07	2.59
1991	1.80	2.09	1.92	2.22
1992	1.91	2.05	2.01	2.15
1993	1.78	1.83	1.59	1.64
1994	**1.75**	**1.75**	**1.83**	**1.83**
AVERAGE		1.77		1.97

Source and Calculation: The unadjusted average price is calculated by dividing the total revenues generated by the total weight sold. The inflation adjustment is made using the 1994 NMI Consumer Price Index (CPI) as the basis by which calculations of previous years' prices are made.

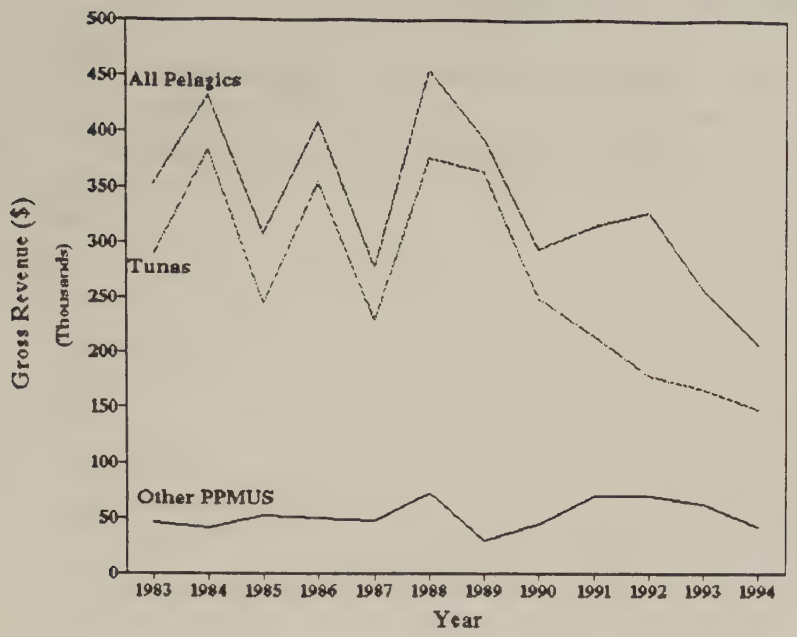
Interpretation: The inflation-adjusted average price of tuna was stable from 1983 until 1989, when an obvious rise was observed. The 1990-92 rise in price corresponds with the notable decrease in skipjack tuna landings (Fig. 3) during the same period of time. 1994 saw

commercially receipted tunas commanding a lower price than in recent years. However, considering the inflation-adjusted prices from 1983 to 1994, it would appear that tuna prices have, on the whole, kept pace with inflation. The real decline in the last two years is likely a symptom of the effects of the NMI's recent economic downturn, as well as an increase in tuna imports.

In 1994 there was a normalization of the relative value of tuna to the "Other PPMUS" category as compared with 1993. This may be due to the decline in catch of mahimahi (Fig. 2) and the itinerant effects on market demand.

The data also suggest that fish in the "Other PPMUS" category did not kept up with inflation in 1993 and 1994. The long-term average ($1.97/lb) is the same as the inflation adjusted price in 1983.

Figure 7. NMI annual commercial adjusted revenues.



	Revenues ($)					
	All Pelagics		Tunas		Other PPMUS	
Year	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1983	198,710	351,717	162,240	287,165	25,770	45,613
1984	264,203	430,651	235,262	383,477	24,503	39,940
1985	195,372	306,734	155,171	243,618	33,162	52,064
1986	267,013	408,530	231,745	354,570	32,631	49,925
1987	190,150	277,619	156,634	228,686	32,333	47,206
1988	327,260	454,891	270,679	376,244	51,950	72,211
1989	299,142	391,876	276,671	362,439	21,635	28,342
1990	235,520	294,400	198,775	248,469	34,968	43,710
1991	271,030	314,395	185,662	215,368	60,031	69,636
1992	305,927	327,342	166,235	177,871	90,627	96,971
1993	249,136	256,610	161,100	165,933	60,001	61,801
1994	**207,124**	**207,124**	**147,940**	**147,940**	**41,548**	**41,548**
AVERAGE		335,157		265,982		54,081

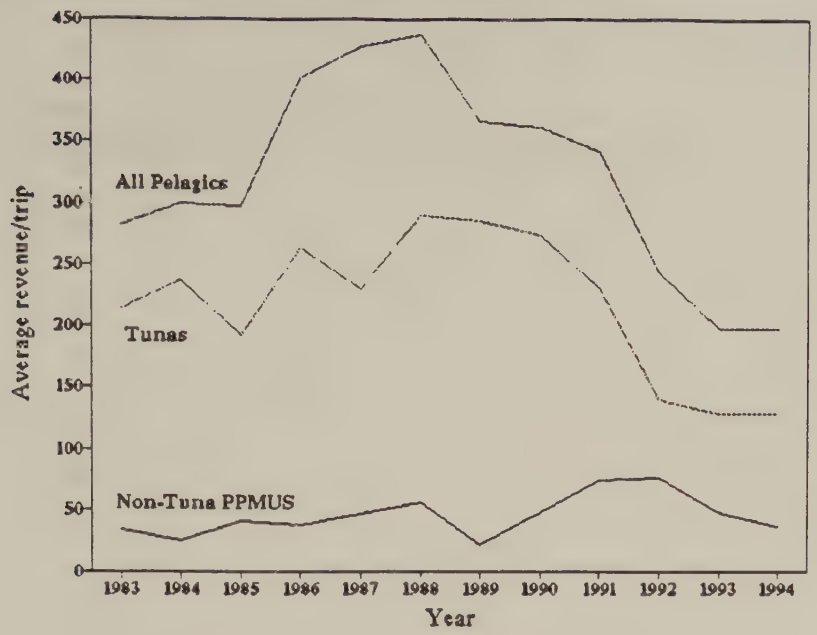
Source and Calculation: Annual revenue in dollars was summed separately for all pelagic fish, tunas and other PPMUS. Inflation-adjusted revenues were calculated using the Consumer Price Index, with 1994 as a base by which previous years' nominal prices are adjusted.

Interpretation: The erratic fluctuations of the inflation-adjusted revenues for Tunas and for All Pelagics prior to 1990 is most likely due to the annual variations in skipjack tuna landings (see Fig. 3) which completely dominate the tuna category and, therefore, the All Pelagics category.

The anomalous divergence of All Pelagics and Tunas in 1991 and 1992, which normally track together, is corrected between 1993 and the end of 1994.

The decline in the tunas' inflation-adjusted revenues, which began in 1990, hit a new low in 1994 and represented only 56% of the twelve year average. "Other PPMUS" inflation-adjusted revenues decreased by 33% in 1994 (from 1993) and was one of the slowest years in this recorded history.

Figure 8. NMI annual commercial adjusted revenues for PPMUS trips only.



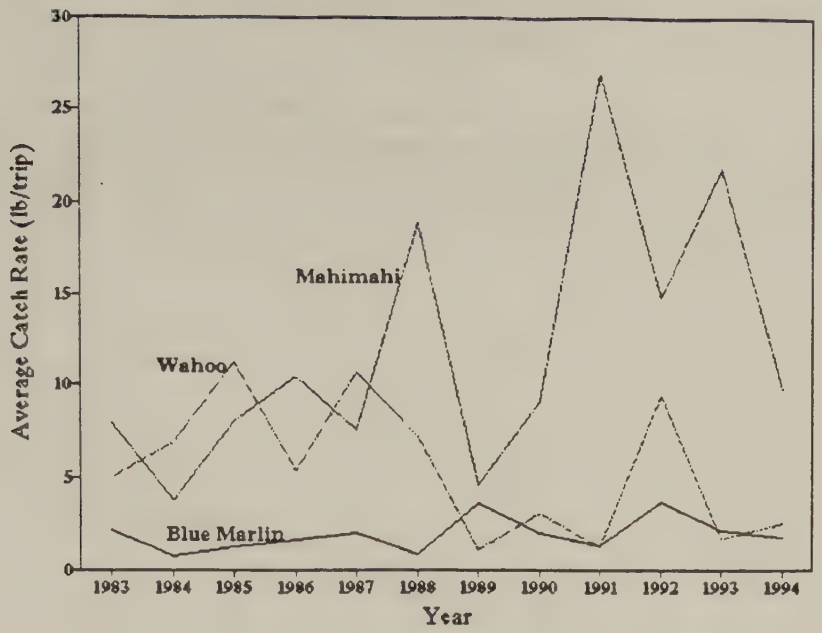
	Revenues per PPMUS Trip ($)					
	All Pelagic Species		Tunas		Other PPMUS	
Year	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1983	159	282	121	214	19	34
1984	183	299	145	237	15	25
1985	189	297	122	192	26	41
1986	262	401	172	264	24	37
1987	292	427	157	230	32	47
1988	315	437	209	290	40	56
1989	279	366	218	286	17	22
1990	289	361	219	274	39	48
1991	295	342	199	231	64	75
1992	228	244	130	140	71	76
1993	192	198	125	129	47	48
1994	**197**	**197**	**129**	**129**	**36**	**36**
AVERAGE		321		218		45

Source and Calculation: Values were obtained by selecting, from the Commercial Purchase Data Base, all trips which landed at least one PPMUS, and then calculating a) the average revenue of all species, b) the average revenue of other PPMUS only, and c) the average revenue of tuna only. Inflation-adjusted revenues were derived from the NMI Consumer Price Index (CPI) which used 1994 as a base.

Interpretation: The precipitous decline of inflation-adjusted revenues per trip for "All Pelagic Species" and "Tunas" appear to have stabilized in 1994. The current year inflation-adjusted values for all categories are well below their respective 12-year means.

Inflation-adjusted revenue per trip for "Other PPMUS" decreased for a second consecutive year, this time by 25% (from 1993). The reason for the 1993-94 decrease is unknown.

Figure 9. NMI trolling catch rate of mahimahi, wahoo and marlin.



	Trolling Catch Rate (lb/trip)		
Year	**Mahimahi**	**Wahoo**	**Marlin**
1983	7.92	4.98	2.15
1984	3.73	6.90	0.76
1985	8.02	11.29	1.15
1986	10.50	5.35	1.57
1987	7.61	10.73	1.97
1988	18.87	7.17	0.80
1989	4.60	0.99	3.59
1990	9.13	3.04	1.92
1991	26.95	1.21	1.32
1992	14.79	9.47	3.68
1993	21.80	1.64	2.14
1994	**9.82**	**2.53**	**1.73**
AVERAGE	11.98	5.44	1.90

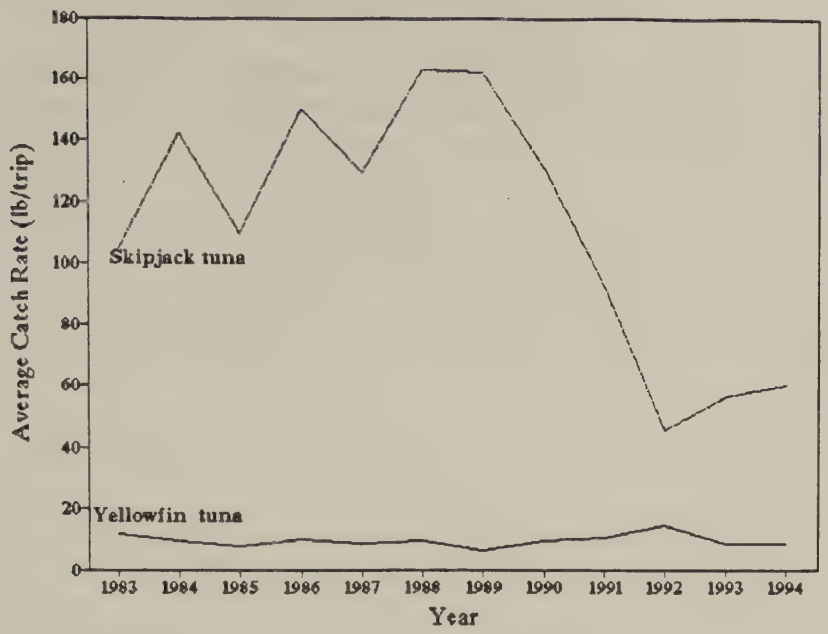
Source and Calculation: Annual catch rates for selected species were obtained by calculating the average weight per trip for each year. Trips were assumed to be one day in length and each commercial invoice assumed to represent one trip.

Interpretation: The 1994 mahimahi catch rate was about half of the previous year's record and under the twelve year mean. This could be due in part to the loss of FADs, which make the fish more accessible. It may also be biological-- note that the trolling catch rates of Guam and the NMI have fluctuated similarly over the last twelve years.

Prior to the 1989 record low, wahoo catch rates rivaled mahimahi. Wahoo catch rates have generally never regained those historical levels. Last year's catch rate was less than half the twelve year mean and only 80% of the mean since 1989.

Marlin catch rates, relative to mahimahi and wahoo, are normally fairly low (record high catch rate of 1.7 kg/trip in 1992). Although the 1994 catch rate decreased, it remained close to the 12-year mean. The higher catch rates exhibited during 1992 and 1993 could be due to a developing charterboat fishery which may tend to target this species more often.

Figure 10. NMI trolling catch rates of skipjack and yellowfin tuna.



	Trolling Catch Rate (lb/trip)	
Year	**Skipjack**	**Yellowfin**
1983	104.21	12.09
1984	142.40	9.59
1985	109.75	7.71
1986	150.07	9.98
1987	129.33	8.37
1988	163.25	9.42
1989	162.08	6.36
1990	130.55	9.20
1991	92.46	10.41
1992	45.47	14.25
1993	56.48	8.65
1994	**60.42**	**8.68**
AVERAGE	112.21	9.56

Source and Calculation: Data were summarized from the Commercial Purchase Data Base, which provides average pounds caught per trip. Annual catch rates for selected species were obtained by calculating the average weight per trip for each year. Trips were assumed to be one day in length and each commercial invoice represents one trip.

Interpretation: Catch rates for skipjack tuna decreased dramatically commencing in 1990. Although the 1993 and 1994 catch rates show signs of stabilizing, they remain far below their respective means. Skipjack tuna are the preferred species in the troll fishery of the NMI because of their relative ease of capture and local popularity. Previous discussions have suggested that

non-tuna PPMUS may be increasing in value and a slight shift in target troll fish may be occurring, especially since the skipjack tuna no longer appear to be as abundant.

Catch rates of yellowfin tuna per trip also appear to have stabilized after having peaked in 1992. It was still lower than the tabled mean in 1994. Yellowfin tuna were not encountered often and were usually taken incidentally while targeting other species.

Appendix 5

Research and Publications

NMFS Honolulu Laboratory

The following section consists of paragraphs extracted from the NMFS Honolulu Laboratory's contributions to the Southwest Fisheries Science Center's bi-monthly and quarterly activity reports in 1994.

Remote Sensing of Ocean Color using SeaWiFS

The Coastal Ocean Program's Hawaii Regional CoastWatch Node (HRCN), Honolulu Laboratory, is dedicated to providing government agencies and researchers with remotely sensed environmental data to assist in managing living marine resources and coastal ecosystems. Toward this end the HRCN, in cooperation with the National Weather Service (NWS), has expanded the capabilities of the NWS's satellite receiving station to acquire Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite data. SeaWiFS data will bring to the ocean community improved renewal of the ocean color remote-sensing capability lost when the Nimbus-7 Coastal Zone Color Scanner (CZCS) failed in 1986. SeaWiFS data will be used to help visualize the variability in ocean color which is related to the distribution of chlorophyll and other water constituents; thus, changes in ocean color reflect changes in primary productivity. The CZCS data provided researchers a valuable tool for studying primary productivity changes on global scales.

Similar data will become available after the launch of the SeaStar™ satellite by Orbital Sciences Corporation (OSC); this satellite will be used to carry the SeaWiFS sensor. In order for researchers to gain quick access to these data, they must sign a "Dear Colleague Letter" with NASA. This letter is written so that users of SeaWiFS data agree to use the data only for noncommercial purposes. Other users must purchase SeaWiFS data from OSC. Investigators desiring SeaWiFS data should request a copy of the Dear Colleague Letter from GSFC, SeaWiFS Project, Code 970.2, NASA, Goddard Space Flight Center, Greenbelt, MD 20771; telephone (301) 286-9676; fax (301) 286-3221; Omnet: SeaWiFS Project.

Pelagic Ecosystems Program--Two Papers Published

A study on the horizontal and vertical movements of striped marlin (*Tetrapturus audax*) near the Hawaiian Islands as determined by ultrasonic telemetry with simultaneous measurement of oceanic currents has recently been published in *Marine Biology*. This paper was co-authored by Fishery Biologist Richard W. Brill, Honolulu Laboratory; David B. Holts, SWFSC, La Jolla; Fishery Biologist Randolph K.C. Chang, Honolulu Laboratory; Scott Sullivan, NOAA Corps; Heidi Dewar, Scripps Institution of Oceanography; and Francis G. Carey, Woods Hole Oceanographic Institute. Fish movements were monitored using ultrasonic depth-sensitive

transmitters, depth-temperature profiles were made using an expendable bathythermograph system, and oceanic current patterns were measured using an acoustic Doppler current profiler. Striped marlin near Hawaii, like Indo-Pacific blue marlin (*Makaira mazara*), spent over 85 percent of their time in the mixed layer (i.e., above 90 m). The maximum depth for striped marlin appears to be limited by water temperatures 8°C colder than the mixed layer, rather than by an absolute lower temperature. The paper also showed that the horizontal displacements of some striped marlin can be strongly influenced by currents.

Another recent publication, "Effects of Entanglement and Escape from High-Seas Driftnets on Rates of Natural Mortality of North Pacific Albacore, *Thunnus alalunga*", was coauthored by Brill and Holts and was published in *Fishery Bulletin*. Foreign driftnet fleets and US trollers taking albacore target a common stock. Albacore that encounter driftnets, then escape, and survive long enough to be recaptured by another fishery, can bear some external marks. US trollers operating in the North Pacific have reported an increased frequency of net-marked fish with the expansion of the Taiwanese, Korean, and Japanese high-seas driftnet fleets. This study was undertaken to determine whether albacore that encounter driftnets, and subsequently escape alive, suffer higher than normal rates of natural mortality.

Standard fitness, short- and long-term growth rates, and indications of bacterial infection and long-term stress were measured to evince differences in rates of natural mortality. Indirect measures were employed because rates of natural mortality (or physiological changes) could not be directly observed in albacore encountering simulated driftnets in shoreside tanks.

No differences were found in any parameter that would indicate differences in natural mortality. Most fish recaptured by trollers were only minimally damaged or had healed scars, however, which may explain the lack of differences. There is most likely a spectrum of damage caused during encounters with driftnets. The number of albacore falling out dead, or escaping so badly injured that they succumb before becoming vulnerable to recapture by troll vessels, may well be significant but remains to be determined.

Fish and Cephalopod Catch in North Pacific High-Seas Driftnet Fisheries Estimated for 1990 and 1991

Since the late 1970s, large-scale high-seas driftnet fisheries have been the dominant fisheries in the North Pacific Transition Zone. Three species (or faunal groups) that have traditionally been targeted by the driftnet fisheries are neon flying squid (*Ommastrephes bartramii*), tunas and billfishes. Vessels from Japan, Taiwan, and the Republic of Korea targeted neon flying squid and comprised the squid driftnet fishery. Other vessels from Japan and Taiwan targeted tunas and billfish and comprised the large-mesh driftnet fishery.

The rapid expansion of large-scale driftnet fishing during the early 1980s led to increasing concern over the incidental killing of non-targeted species (including marine mammals, sea birds, turtles, and salmonids) by the driftnet fisheries, and its potential impact on the ecosystem resulted in the adoption of stricter time-area regulations and development of international monitoring programs. In 1989 a cooperative pilot scientific observer program was established between Japan, Canada,

and the United States. Later bilateral observer programs were launched by the USA and the Republic of Korea, and the USA and Taiwan. The goals of the scientific observer programs were to monitor driftnet fishing operations and obtain data on the rates of incidental take of various species of fish, marine mammals, turtles, and birds in an effort to estimate total mortalities and to assess impacts on the affected populations. Increased public concern over the potential impact of these fisheries resulted in a global United Nations ban on large-scale driftnet fishing effective 31 December 1992.

Total catches (numbers and biomass) of squids and pelagic fishes in the North Pacific high-seas drift gillnet fisheries have been estimated for the 1990 and 1991 fishing seasons. These estimates are based on data collected by multinational scientific observers and total fleet effort reported by the fishing nations. Catch was examined relative to the type of fishery (squid or large-mesh), the flag of the vessels involved (Japan, Korea or Taiwan), and physical and operational factors affecting catchability.

An initial step towards estimating total catches required the assessment of "dropouts" during net retrieval. A dropout is defined as an animal that emerges from the water entangled in the net but becomes disentangled and falls out of the net before it reaches the deck, either on its own or by the crew's deliberate shaking of the net. A General Linear Model (GLM) was used to explore factors that may be correlated with net retrieval dropouts, and the reported number of fish decked were "scaled-up" using mean dropout rates. Total catches by species and month were estimated using a ratio estimator. Species-specific metrics of exploited biomass were estimated by apportioning total catches into length categories based on length frequency data collected by observers, then converting catch-by-length to catch-by-weight using existing or derived length-weight relationships. Precision of the estimates of total catch was evaluated by bootstrap re-sampling.

Summaries of total fleet fishing effort, observed fishing effort, and observer coverage rates in the 1990 and 1991 fishing seasons are presented. Observers reported eight cephalopod and 76 fish species caught in the 1990 and 1991 fishing seasons representing five faunal groups--squids, sharks, tunas, billfishes, and other pelagic fishes. For most species, dropout rates were similar between years. However, differences in dropout rates between fisheries were apparent. Dropout rates were generally lower in the large-mesh fisheries than in the squid fishery for all fish species.

Although the magnitude and composition of catches differed between fisheries and years, highest combined total catches were generally associated with intended target(s): neon flying squid by the squid driftnet fleets and albacore (*Thunnus alalunga*), skipjack tuna (*Katsuwonus pelamis*) and striped marlin (*Tetrapturus audax*) by the large-mesh driftnet fleets. While the catches by the Japanese squid fleet were dominated by neon flying squid, non-targeted pelagic species of low economic value (LEV) accounted for approximately 40% of the total numbers of cephalopods and fishes caught on an annual basis. LEV species are defined as those species included in the two faunal groups "other pelagic fishes" and "sharks." Paramount among LEV species caught by the Japanese squid fleet were Pacific pomfret (*Brama japonica*), pelagic armorhead (*Pseudopentaceros wheeleri*), blue shark (*Prionace glauca*), and yellowtail (*Seriola lalandi*) with catch estimates of approximately 35.1, 3.2, 0.9 and 0.1 million animals in 1990 and 17.5, 0.9, 0.9

and 0.2 million animals in 1991, respectively. Relatively large numbers of LEV species including Pacific pomfret, blue shark and yellowtail were also caught by the Korean and Taiwanese squid driftnet fleets. In 1990, approximately 9.0, 0.7, and 0.07 million and 0.6, 0.1, and 0.005 million Pacific pomfret, blue shark, and yellowtail were caught by the Korean and Taiwanese squid fleets, respectively. In 1991, approximately 1.4, 0.6, and 0.4 million and 0.3, 0.1, and 0.008 million Pacific pomfret, blue shark, and yellowtail were caught by the Korean and Taiwanese squid fleets, respectively.

The catches by the Taiwanese large-mesh fleet were predominately albacore (5.2 million in 1990, 0.7 million in 1991) and skipjack tuna (0.4 million in 1990, 0.3 million in 1991) but species of LEV were also taken, in particular Pacific pomfret (1.3 million in 1990, 0.08 million in 1991). The catches by the Japanese large-mesh fleet were predominately species of LEV, Pacific pomfret (1.5 million) and mahimahi (0.3 million) being most prevalent. Relatively large numbers of albacore (0.2 million) and skipjack tuna (1.4 million) were also caught, as well as neon flying squid (0.6 million).

Highest estimates of total biomass removed occurred in the squid driftnet fisheries. From 1990 to 1991 approximately 461,000 metric tons (t) of squid and fish were caught by the squid driftnet fleets compared with 59,000 t by the large-mesh fleets. Highest biomass removed in the squid fishery was associated with the Japanese fleet (≈231,000 t) followed by the Korean (≈142,000 t) and Taiwanese (≈88,000 t) fleets. In the large-mesh fishery highest biomass removed was associated with the Taiwanese fleet (≈45,000 t). Within fleets, highest biomass removal estimates were associated with target species, followed by species of LEV. Paramount among LEV species were Pacific pomfret and blue shark. Interannual variability in biomass removal estimates was observed, particularly for target species and species of LEV.

The average weight and length of key species were generally larger in the large-mesh fisheries than in the squid fisheries. Within the squid driftnet fishery, no apparent trend in average weight and length of key species was observed between fleets. However, in the large-mesh fishery the Japanese fleet generally caught larger fish compared with the Taiwanese fleet.

Hawaii Pelagic Fishing Vessel Economics Project (HIFIVE)

The HIFIVE project was initiated in the first quarter of 1994 at the NMFS Honolulu Laboratory with the overall objectives being to determine the economic characteristics and optimal number (and spatial distribution) of Hawaii-based domestic longline fishing vessels; to identify the determinants of longline fishing vessel operations (spatial, temporal, and species) relative to interaction with other domestic fishing fleets; and to identify the economic characteristics of commercial troll-handline and charter boat operations.

HIFIVE is comprised of seven sub-projects emphasizing different aspects of economic research on Hawaii's commercial fishery for pelagics (primarily tuna, swordfish, blue and striped marlin, and mahimahi and ono). The pelagic fisheries under consideration by the HIFIVE project include the following domestic commercial fishing fleets based in Hawaii: longline, commercial troll and

handline, and charter-boats, as well as some research on the markets associated with these fleets. The seven sub-projects include:

- Hawaii pelagic fisheries data management
- Hawaii longline fishery cost/earnings analysis
- Institutional structure of Hawaii's longline fishery
- Production modeling of the Hawaii longline fishery
- Economic analysis of catch and effort in Hawaii's longline fishery
- Hawaii's pelagic fishery market dynamics
- Hawaii small-boat commercial pelagic fishery cost/earnings analysis

This project should provide fishery management information based on the economic characteristics of the Hawaii longline and troll-handline (including charterboat) fisheries. The primary client for the research is the Western Pacific Regional Fishery Management Council (Council). The first year of the project (1994) concentrated on the Hawaii longline fishery. A number of integrated and summarized databases were constructed for economic analysis purposes. The longline costs and operations survey has been completed, and a cost-earnings analysis is being completed, with earnings data generated by merging NMFS longline logbook information with Hawaii Division of Aquatic Resources (HDAR) commercial catch reports. Recently HIFIVE staff have concentrated on enhancing revenue information for the Hawaii longline fishery by interviewing vessel owners and captains as well as fish dealers and brokers. A particular problem has been the price of swordfish as recorded in the HDAR commercial fishing catch reports. Much of the swordfish landed in Honolulu is sold on consignment in the continental USA, with prices being quoted substantially after the sale (sometimes as much as three months later). To remain current with their HDAR reports, some swordfish vessel captains estimate the revenue they expect to receive and report that revenue. Preliminary investigation by the HIFIVE staff suggests that these estimates are at best first approximations of final sales revenue. There does not appear to be a particular upward or downward bias in the quoted revenues. Results of these investigations will be included in the HIFIVE report on longline cost and earnings study but because of the extent of these investigations, the final report may be delayed until later this summer.

Substantial progress has also been made on analysis of institution, production, and market relations concerning the Hawaii longline fishery. The second year project (1995) will extend the economic analysis of the Hawaii longline fishery and collect economic information on the small-boat commercial pelagic fisheries in Hawaii. The Hawaii Pelagic Fishing Vessel Economics project is expected to last 3 years, depending on funding availability for the second and third years.

Marine Fisheries Review Special Issue Published

The special issue of *Marine Fisheries Review,* edited by former Honolulu Laboratory Director George Boehlert, was published in the second quarter. This issue, The Fisheries of Hawaii and U.S.-associated Pacific Islands, is the first published source of fisheries information for Hawaii and the US-associated Pacific Islands available to scientists and the general public. Its scope is

limited to domestic island-based pelagic and insular, rather than distant-water, fisheries, thereby excluding tuna purse seine and albacore fisheries and island-based foreign fleets in the case of Guam and American Samoa. Each article includes information on the biology of the species involved, a synopsis of the fishery, current research and research needs, issues associated with management and regulation of the fishery, and future prospects.

Remote Sensing of Sea Surface Temperatures Using NOAA AVHRR Data

The Coastal Ocean Program's Hawaii Regional CoastWatch Node (HRCN), Honolulu Laboratory, is dedicated to providing government agencies and researchers with remotely sensed environmental data to assist in managing living marine resources and coastal ecosystems. To be effective, the data provided by CoastWatch must be both timely and at a level of processing that would provide usable and immediate information to users without sophisticated image processing systems.

Toward this end the HRCN has installed a computer network (CoWaNet) to directly access satellite data from the National Weather Service (NWS) in Honolulu, Hawaii. In particular, the HRCN now obtains four to six passes daily of Advanced Very High Resolution Radiometer (AVHRR) data from NOAA Polar orbiting satellites.

Data from these passes are used to derive Sea Surface Temperature (SST) images for different regions of the central Pacific. To facilitate analysis and use of these data, the CoastWatch program provides a software package, Ccoast, which may be used to view these data on any PC with a Multisync or Super VGA monitor, 1 MB of Expanded Memory, 400K of available system RAM, and mouse or other pointing device. Internet users with signed Memorandums of Agreement may acquire these data in real-time for display on their local DOS computers.

Investigators desiring CoastWatch AVHRR data should contact Craig Motell at the Honolulu Laboratory of the National Marine Fisheries Service using the Internet address "cmotell@pelagos.nmfs.hawaii.edu".

Teachers and Students Participate in Longline Research Cruise

Participants in NOAA's "Teacher at Sea" program and students and researchers from the University of Hawaii were hosted by the Honolulu Laboratory and the NOAA Ship Townsend Cromwell on the summer 1994 pelagic longline research cruise TC-94-05. The teachers, students, and cooperating scientists were involved in all phases of the cruise. For some, this was their first at-sea experience, but all were quickly acclimated and became a functional research team. Everyone worked well together and experienced long hours and hard work, including bait and catch processing, data logging, and computer data processing. The success of the cruise was due in large part to the full participation of the teachers and students.

Daily cruise activities began at 5:30 am with the setting of longline gear with attached timing and depth recording devices (TDRs), followed by a conductivity-temperature depth cast. Fishing gear damaged or lost the previous day was then repaired or replaced. At 2:30 pm, the fishing gear was

retrieved. Generally, live fish were either tagged and released or placed in the bait well for further study at the Kewalo Research Facility or for live exhibits at the Waikiki Aquarium. Tagged billfish were also injected with tetracycline to determine age from fish otoliths upon recapture. Gear position and catch morphological data were recorded, along with capture times indicated by hook timers triggered when fish bit the hooks. Samples of parasites, muscle, gonad, and stomach contents were labeled and preserved. At the end of the day, TDRs were downloaded, and preparations were made for the next day of fishing. The day usually ended at 9:00 pm or later.

During breaks in this busy schedule, the teachers and students learned about the operation and functions of the ship from its officers and staff and participated in discussions about research objectives of the cruise with scientific personnel. Teachers and students gained new experiences, as well as an awareness of life aboard ship which they will share back home. They were exposed to a window of marine science that is not possible in the classroom and helped the Waikiki Aquarium acquire a rare pelagic sting ray for an attractive display specimen in the aquarium's new pelagic exhibit.

The experiences of Kathleen Heidenreich, a teacher from Lacey, Washington, who participated on a R/V *Townsend Cromwell* longline cruise in 1993, have recently been published in *Currents: The Journal of Marine Education.* 12(3): 26-32.

Hawaii Swordfish Fishery Oceanography Grant Awarded

A major requirement for improving the assessment of the swordfish resource exploited by the Hawaii longline fishery is an evaluation of environmental influences affecting the availability and vulnerability of the resource. Toward this end, a new research project was initiated in December 1994 with funding provided by the Joint Institute of Marine & Atmospheric Research (JIMAR) Pelagic Fishery Research Program (PFRP) at the University of Hawaii. The project will incorporate remotely sensed and in situ environmental information into a fishery performance model for swordfish in the central North Pacific.

Initial goals of the project are to 1) examine and quantify environmental features, especially sea-surface temperature gradients, that are expected to be important to the dynamics of swordfish distribution and gear vulnerability, and 2) improve interpretation of swordfish catch-per-unit-effort data used by the Western Pacific Regional Fishery Management Council in evaluating management alternatives for the domestic longline fishery. Several other cooperating PFRP projects will investigate sea level variation, ocean color, and circulation patterns that may be relevant to swordfish distribution and vulnerability. Once relevant features are identified and quantified at the appropriate scale these factors will be incorporated into comprehensive swordfish fishery dynamics models.

International Symposium on Pacific Swordfish

Honolulu Laboratory and Council representatives participated in the International Symposium on Pacific Swordfish held in Ensenada, Baja California, Mexico, 11-14 December 1994. The symposium was organized by the Centro de Investigación Científica y Educación Superior de

Ensenada and the NMFS Southwest Fisheries Science Center. Funding was provided by the Mexican Swordfish Fishery Section of the National Fishing Industry Chamber (CANAINPES in Spanish), the Third World Academy of Sciences, and the Northwest Marine Technology, Inc.

With growing market demand for swordfish, fisheries in the Pacific including the Hawaii-based fishery and those off the west coast of the USA, Mexico, and Chile have expanded significantly in recent years. The purpose of the symposium was to update information on the expanding Pacific swordfish fisheries, exchange knowledge of swordfish trends and swordfish biology, and stimulate international cooperation in swordfish research. Scientists from Australia, Chile, and Japan attended in addition to those from Mexico and the USA. Swordfish research programs in the Atlantic and Pacific Oceans were also represented.

Three papers were presented by Honolulu Laboratory fishery biologists and another by researchers associated with the NOAA/University of Hawaii Joint Institute for Marine and Atmospheric Research (JIMAR). Robert Skillman presented a paper entitled "Central Pacific Swordfish Status Report" in which he described the recent development of the Hawaii longline fishery for swordfish and world landings for perspective, reviewed swordfish biology and population dynamics in the Pacific and Atlantic oceans, and described Honolulu Laboratory fishery monitoring and research strategies. Russell Ito presented the paper "The Hawaii Longline Fishery for Swordfish" coauthored with Robert Dollar and Kurt Kawamoto. This paper profiled the Hawaii-based domestic longline fishery describing the gear and fishing practices, landings and revenue, participants, and the product and its distribution. James Uchiyama's paper "Ageing of North Pacific Swordfish Using Hard Parts" was coauthored with Skillman and Jeffrey Sampaga, biological laboratory technician. Progress made on developing techniques for determining the age of swordfish from fin spines, otoliths, and vertebrae and establishing relationships between size measurements for these tissues and whole animal measures were described. A provisional growth model was also presented. Gerard DiNardo of JIMAR presented the paper "Spatio-temporal Dynamics of Broadbill Swordfish (*Xiphias gladius*) Landings in the Hawaii-based North Pacific Pelagic Longline Fishery." The paper, coauthored with fellow JIMAR investigator William Kwok, characterized the spatial and temporal dynamics of swordfish landings in the Hawaii-based domestic longline fishery and developed preliminary length-based metrics of fishery performance. Several other papers were presented by staff at the La Jolla Laboratory, SWFSC.

Pelagic Fisheries Research Program

The Pelagic Fisheries Research Program (PFRP) was established by the Western Pacific Regional Fishery Management Council in 1992. The program is housed in Honolulu at the Joint Institute of Marine and Atmospheric Research (JIMAR), School of Ocean and Earth Sciences and Technology (SOEST), University of Hawaii at Manoa. The PFRP currently supports over 25 different research projects. The projects involve more than 28 different principal investigators from various institutions including the University of Hawaii, five mainland universities, two NMFS laboratories, foreign laboratories, and private consultants. Numerous associate researchers and student helpers are employed by these projects through JIMAR.

The following section summarizes preliminary results of projects currently in place. Principal investigators are noted in parentheses after the project title. The specific results presented below are preliminary and are only samples of the research results available. New projects are also described briefly.

Local pelagic catch and effort data analysis and integrated modeling to quantify the effects of local fisheries on fish availability. (Christofer Boggs)

This project has been successful in compiling internally consistent catch and effort time series data for catches of yellowfin and bigeye tunas, blue and striped marlin, ono (wahoo), and mahimahi in Hawaii. Catch per unit of effort (CPUE) has remained high when total catch was high implying that the fishery is having little impact on the stock. Trends in catch rates over long time periods show that environmental influences are correlated with catch rate. Various approaches to the problem of non-reporting of zero-catch trips were attempted; biases from this source are consistent and correctable. The problem of interpreting CPUE in the longline fishery when the vessels change their targeting practices was resolved by applying multivariate analysis techniques to the catches. A spatial search model showed that the spatial distribution of fishing may be a good proxy for the spatial distribution of target species. Several reports have been published or are in press; future work will emphasize publication of existing results, refinement of longline targeting and more sophisticated time series analysis.

Analysis of Pacific blue marlin and swordfish population structure using mitochondrial and nuclear DNA technologies. (Barbara Block and John Graves)

Restriction fragment length polymorphism (RFLP) analysis of mitochondrial (mt) DNA was used to investigate population structure of blue marlin in the Pacific and Atlantic Oceans. Composite mtDNA haplotypes representing digestion with 12 restriction endonucleases have been generated for approximately 450 blue marlin from four locations in the Pacific Ocean (Mexico, Ecuador, Hawaii and Australia) and three within the Atlantic Ocean (US mid-Atlantic coast, Jamaica, Brazil). Extremely high levels of mtDNA variation are present in samples from both oceans, with haplotype diversities (the probability of encountering different haplotypes in two draws from a sample) approaching 0.9. Despite the high levels of molecular character variation, significant inter-ocean genetic divergence is apparent. Two major clades of mtDNA haplotypes are present in Atlantic blue marlin, but only one of these is found in Pacific blue marlin. The presence of intra-ocean population genetic structure is also suggested by the spatial partitioning of particular haplotypes. These apparent under- and intra-ocean genetic differences are temporally stable, at least over a period of several years.

The global population structure of swordfish was assessed through sequencing of the 5' end of the highly variable mitochondrial DNA control region from 159 swordfish collected in three ocean basins: the Mediterranean, Atlantic and Pacific. A total of 332 base pairs of sequence were obtained from swordfish collected from the Pacific (n=105), Atlantic (n=23) and Mediterranean (n=20). Phylogenetic analysis of the relationships among the unique DNA haplotypes revealed two deeply divergent clades with differential geographic distributions, similar to what has been found for certain istiophorid billfishes. Phylogeographic concordance among these species

suggests a biogeographic explanation for this structure. The extent of global population subdivision was also examined using an analysis of molecular variance (AMOVA) framework and F-statistic analogs. The results revealed significant geographic partitioning of molecular variance among the three ocean basins, indicating that swordfish populations are structured on a global scale. Estimates of genetic exchange rates among populations within an ocean basin were high, suggesting panmixia within ocean basins. However, much larger sample sizes may be necessary to detect subdivision within ocean basins, because the haplotypic diversity exhibited by the swordfish control region is extremely high.

Automated monitoring of yellowfin tuna at Hawaiian Fish Aggregation Devices and the relationship to water mass dynamics based upon satellite imagery. (Peter Klimley)

Tunas and other pelagic fishes are attracted to almost any floating object. The aggregations thus formed may be quite extensive, and the aggregation phenomenon is exploited throughout the world in a variety of different fisheries. In Hawaii, a network of moored buoys or fish aggregation devices (FADs) has been established, and the fishing community depends on these FADs both to improve fishing productivity and to reduce costs of fishing. The benefits of these devices to the fish are less clear and how the fish actually exploit FADs is almost totally unknown. Yellowfin tunas will be tagged at selected FADs with ultrasonic pingers that broadcast a unique identification signal. Monitoring devices will be deployed on FADs to record the presence of tagged fish over periods of many months. The results will indicate the frequency at which individual fish utilize particular FADs and the oceanographic factors that moderate their near-shore distribution.

Authorization has been obtained from State of Hawaii authorities to attach monitoring devices to FADs. Poor fishing for yellowfin during field periods in 1994 combined with battery failures to restrict the number of functional transmitters that could be deployed to eleven. Two of three monitors also failed. The remaining monitor produced usable data but no record of yellowfin proximity. Temperature and light recorders functioned perfectly.

Field plans for 1995 were revised in response to previous experience. A local full-time research assistant has been employed. The scope of field activity has been enlarged to increase the likelihood of successful field deployment of both transmitters and monitors.

Reproductive biology of yellowfin tuna, *Thunnus albacares*, in Hawaiian waters and the western tropical Pacific Ocean. (Gordon Grau and Richard Shomura)

As of May 1995, some 2,300 formalin-preserved tuna ovary samples have been received in Hawaii from all areas (Philippines, Indonesia, Micronesia, etc) and processed for analysis. An additional 2,000 samples have been collected but not yet received for processing. Over 1,600 samples have been examined and assigned to maturity stages ranging from fully immature to mature with fully atretic oocytes (inactive but previously spawned).

Slide interpretation is ongoing, but all indications are that yellowfin in the western Pacific region exhibit spawning characteristics similar to those documented by other researchers using

histological techniques, i.e., yellowfin are serial spawners with asynchronous oocyte development, releasing millions of eggs per batch during extended periods at nearly daily intervals. Post ovulatory follicles apparently persist for less than 24 hours as indicated for tropical tunas from other regions, and appear to be a reliable indicator of recent spawning activity. Observations of post-ovulatory follicle condition related to time of capture indicates that spawning occurs at night.

Analysis of samples taken by purse seine sets on surface feeding schools, surface log associated schools and sub-surface longline sets produced mean estimates of batch spawning intervals of 1.13, 1.18 and 1.23 days, respectively. The slightly less than daily spawning rhythm is due to the observation that sexually mature female yellowfin pass through phases of active spawning, interspersed with dormant periods characterized by atresia of fully yolked oocytes.

Physical characteristics of the environment influencing pelagic fishes. (Pierre Flament)

The historical database of Argos-tracked drifters has been used to study mesoscale processes in the lee of the Hawaiian Islands. Although the number of drifters is too small to construct instantaneous maps of the flow, the average velocity field reveals a pair of elliptical counter-rotating gyres west of the islands, the cyclonic one to the north of 20°N, the anticyclonic one to the south, The major axis of the gyres extend from approximately 157°W to 161°W. It is hypothesized that these large gyres are the average expression of individual cyclonic and anticyclonic eddies induced by wind shear lines in the lee of the islands, which eventually drift westward and decay.

To confirm this hypothesis, the Central Pacific Drifter Array, consisting of seventy drifting buoys, will be deployed over the next two years to map the flow in the Hawaiian Exclusive Economic Zone. The first batch of 25 drifters was deployed in September 1995 south of the island of Maui; these drifters have been entrained in a large anticyclonic eddy, approximately coincident with the mean gyre. About 25% of the drifters continued westward in the North Equatorial Current, whereas the remaining ones drifted northward and became entrapped in an intense mesoscale eddy field located over the western Hawaiian Islands. The current positions of these drifters are sent to interested people by fax.

Hawaii fishing vessel economics. (Samuel Pooley)

The Hawaii fishing vessel economics (HIFIVE) project is comprised of seven sub-projects emphasizing different aspects of economic research on Hawaii's commercial fishery for pelagics (primarily tuna, swordfish, blue and striped marlin, and mahimahi and ono). The pelagic fisheries under consideration by the HIFIVE project include the following domestic commercial fishing fleets based in Hawaii: longline, commercial troll and handline, and charter-boats, as well as some research on the markets associated with these fleets. The HIFIVE principal investigator also collaborates formally with the University of Hawaii's Department of Agricultural & Resource Economics (AREC) project on a multi-level, multi-objective programming model of Hawaii's pelagic fisheries.

The first year of the project (1994) concentrated on the Hawaii longline fishery. A number of integrated and summarized data bases were constructed. A longline costs and operations survey has been completed. A cost-earnings analysis is near completion using earnings data generated by merging NMFS longline logbook information and Hawaii Division of Aquatic Resources commercial catch reports. Substantial progress has also been made on analysis of institution, production, and market relations concerning the Hawaii longline fishery. The continuation of this project will extend the economic analysis of the Hawaii longline fishery and collect economic information on the small-boat commercial pelagic fisheries in Hawaii.

Social aspects of the Hawaiian pelagic troll fishery. (Marc Miller)

The troll and handline sector of the Hawaii offshore fishery consists of thousands of small (under 45 feet) vessels targeting tunas, billfish, and other fish in the Pacific Pelagic Management Unit Species complex managed by the Western Pacific Regional Fishery Management Council. In allocating opportunities to fish in accordance with the optimum yield mandate of the Magnuson Fishery Conservation and Management Act of 1976, the Council takes into account patterns of fishermen's commitment to fishing as well as their influence on fishing effort. A pilot survey of 49 fishermen on Oahu and Hawaii was conducted. Analysis of the data show that fishing is a social production with *holoholo* (recreational), *kaukau* (food), expense (cost of gas and supplies), and profit dimensions. Multidimensional scaling and cluster analysis reveal how fishermen classify major pelagic species. Research questions identified by fishermen reveal an intuitive perception of some of the principle scientific problems facing the PFRP.

Structure and dynamics of the US tuna market for fresh Pacific tuna and marlin. (John Kaneko, Paul Bartram and Peter Garrod)

Fresh tuna is not a single commodity but an array of products. During marketing and distribution, each tuna acquires an individual identity (i.e., a "grade") that is maintained until final sale and consumption. The identity directs different grades of tuna to different market niches and end uses. The relationship between tuna grades and price fluctuations (first purchase) in the Hawaii tuna fishery is the focus of this research. During July 1994, market data, including price, fish grade and method of capture, were collected for nearly 2,000 transactions at the Honolulu fish auction. More aggregated data were collected for most fresh tuna sales in Hawaii, Japan, the continental USA and Europe.

A second round of data collection is planned for June 1995, but the preliminary data base suggests that fish grade (including size) and linkages of specific grades to specific products and end uses explain more of the short-term price variation in Hawaii's fresh tuna market than does harvesting method. Market competition among tuna fishermen using different gear types (longline, handline, troll) is less than imagined.

A database on marlin sales in Hawaii's fresh fish market has also been developed and more aggregated data have been collected for the continental US and Japan markets. Preliminary findings suggest that the marlin market is much less stratified in terms of grades and product types than is the fresh tuna market.

Contributions of tuna fishing and transshipment operation to local economies. (Michael Hamnett)

Tuna fishing and transshipment are important to the economies of American Samoa, the Northern Mariana Islands (NMI) and Guam. In American Samoa, tuna canneries and the goods and services purchased by the fleets are the major sources of private sector economic activity. In Guam, transshipping and providing goods and services to tuna boats are minor industries compared to tourism. They are, however, one of Guam's few options for economic diversification. The NMI, also largely a tourism economy, is a major transshipment point for both cannery grade tuna through Tinian and sashimi grade tuna through Saipan bound for the Japanese market. The NMI has not, however, benefitted economically as much as American Samoa and Guam because of a lack of infrastructure and vessel support businesses.

Since the early 1990s, tuna processing in American Samoa, tuna transshipment and home-porting in Guam, and transshipment in the NMI have been undergoing changes that make the future of tuna related industries very uncertain. The canneries in American Samoa have struggled to survive in the face of foreign competition for many years, and rumors began circulating in 1994 that one of the two canneries plans to close in the near future. The transshipment operation in Tinian began to decline in 1993, and the vessels that transshipped at Tinian were slated to move to Papua New Guinea to supply a canary that was to be built in Madang. Port calls at Guam also began to decline in 1993 as a result of new licensing requirement for Taiwanese boats imposed by the Federated States of Micronesia.

The prospects for tuna fishing and transshipment in all three jurisdictions looked poor in 1994. Since that time, observers have become more optimistic. It appears that at least one of the canneries will remain in American Samoa, and it looks possible that both Samoa Packing and StarKist Samoa will remain for the time being. Port calls at Tinian remained steady through 1994, and the agreement to develop a cannery in Papua New Guinea has reportedly been shelved. Port calls in Guam rebounded in 1994, and two new transshipment operations have been established there.

Integrative modeling in support of the Pelagic Fisheries Research Program: Spatially disaggregated population dynamics models for pelagic fisheries. (John Sibert)

The general objective of the proposed research is to integrate the results of different PFRP components into spatially disaggregated models of pelagic fisheries which integrate knowledge of fish movement, the fishing process, economics and oceanography. The character of this project was changed greatly by amalgamation with another PFRP project, "Design of tag-recapture experiments for estimating yellowfin tuna stock dynamics, movements, and fishery interactions". The status of the tag-design project is reported separately.

The existing model western Pacific skipjack movement was modified to include both seasonal and spatial variability in diffusion. In addition, fishing effort observations, stratified by month and one-degree geographic square, were included. This model was applied to skipjack tagging data from two South Pacific Commission tagging experiments and the results were used to analyze

potential fishery interactions between purse seine and pole and line fisheries for skipjack. The results emphasized the importance of both directed and random components of movement in determining the large scale distribution of skipjack. Natural mortality emerged as an important determinant of the potential for fisheries interaction. The potential decline of pole and line catches of skipjack due to catches by the purse seine fleet ranged from 5% to 30% depending on distance between fisheries and natural mortality. This work was reported at the FAO expert consultation on interactions of Pacific Tuna Fisheries, held in Shimizu, Japan, in January 1995.

The model software, originally written for personal computers, was modified to run on a Sun SPARCStation 20. A set of graphics routines was written that allow the same basic software to run on either a PC or an XWindows terminal without modification to the source code.
A preliminary model was developed which can, in principle, estimate movement and population dynamics parameters from the spatial distribution of catch and effort. Considerable work is required to get this model into working condition.

The model was extended spatially in two different modes. The boundaries of the western Pacific skipjack model were extended to the Asian continent, 170°W, 40°S and 40°N. This large model area will be used to analyze both yellowfin and skipjack tagging results. Scientists from the Tohoku Regional Fisheries Laboratory in Japan will be collaborating in the skipjack analysis. The model was also adapted to a different ocean basin including the entire North Atlantic Ocean, Caribbean and Mediterranean Seas in order to assist in planning a study of Atlantic bluefin tuna migrations. This work was done in collaboration NMFS scientists in La Jolla and Miami.

Design of tag-recapture experiments for estimating yellowfin tuna stock dynamics, movement and fishery interactions. (John Sibert)

Several important modifications were made to the large-scale skipjack model to adapt it to the smaller scale problem of movement within the Hawaii fisheries area. A space-centered difference scheme was implemented for the advective terms to increase its accuracy. This modification effectively eliminates the "numerical viscosity" introduced by the upwind differencing scheme used in the large scale model. The model was adapted to optionally use advection and diffusion fields generated from numerical circulation models. This modification will enable evaluation of the relative importance of behavior and transport by ocean circulation in controlling the distribution of tunas.

Alternative movement and mortality hypotheses have been developed for Hawaii yellowfin tuna populations. These hypotheses are used to generate predicted distributions of tagged fish resulting from different tag release strategies in the Hawaii region. The ability to deduce the movement and mortality patterns from the tag distributions will be used to evaluate the effectiveness of the tag release strategies. Preliminary results of the Hawaii tag distribution analysis will be presented at the Research Planning Workshop for Atlantic Bluefin Tuna Tagging Studies to be held in Miami in August 1995.

The distribution of fishing mortality in the small scale model is computed from the observed distribution of fishing effort and yellowfin catch by Hawaii based fishing fleets supplied by other

PFRP projects. Specifically these fleets include subdivisions of the longline fleet (based on targeting differences), troll, and handline.

Laboratory and field research to enhance understanding of tuna movements and distribution, and to improve stock assessment methods. (Richard Brill, Gordon Grau and Kim Holland)

Funds were allocated to this program 1 January 1995. The period from 1 Oct 94 to 1 Jan 95 was used to recruit and interview candidates for two positions, participate in a yellowfin tracking cruise, and complete a review manuscript on the evolutionary and ecological aspects of the high performance physiology of tunas, billfishes, and dolphinfish. A research associate and postdoctoral researcher have subsequently been hired. Experiments have been completed to measure the volumes of the primary and secondary circulatory systems, and to determine the effects of acute temperature change on cardio-respiratory function in yellowfin tuna.

Integration of longline fishery performance model with environmental information. (Christofer Boggs)

The goal of this project is to improve the assessment of the swordfish resource exploited by Hawaii longline fishermen by incorporating and evaluating environmental influences affecting the availability and catchability of the resource. Initial goals of the project are to 1) examine and quantify environmental features, especially sea surface temperature (SST) gradients, that are expected to be important to the dynamics of swordfish distribution and gear vulnerability, and 2) improve interpretation of swordfish catch per unit of effort (CPUE) data used by the Western Pacific Regional Fishery Management Council in evaluating management alternatives for the domestic longline fishery.

A full-time fishery oceanographer was hired in January 1995. An office was established for the project at the Honolulu Laboratory of the National Marine Fisheries Service. Progress through June 1995 included 1) acquisition and manipulation of AVHRR satellite data sets from the Jet Propulsion Laboratory and National Center for Atmospheric Research, 2) mapping the distribution of swordfish longline effort for 1991-92 with concurrent SST measurements, 3) estimation of the frequency distribution of swordfish longline sets with regard to sea surface temperature (SST), and 4) development of statistical relationships to describe CPUE trends due to lunar effects.

Research on the fleet dynamics of swordfish fishermen in association with SST and lunar effects on CPUE were presented at the Tuna Conference in Lake Arrowhead, California. A mesoscale approach was initially taken in developing associations between SST and fleet distribution. Mapping of SST data at a time scale of one week and a space scale of 18-km demonstrated that latitudinal changes in fishing effort correspond with isotherm movements. The distribution of fishing effort and SST was bimodal, with modes occurring at 18° and 23°C. The apparent differences in SST preference may be related to vessel size rather than seasonal influences. Effort in the Hawaii longline fisheries is significantly autocorrelated on lunar and seasonal scales. Corresponding CPUE estimates were also autocorrelated on a lunar scale for all tunas, swordfish

and mahimahi, but not correlated for sharks and istiophorid billfishes. Statistical analyses between CPUE and a lunar time series showed that CPUE was coherent with moon phase at short time lags (<3 days) for most species; thus higher CPUE was associated with the full moon.

Evaluation of remote sensing technologies for the identification of oceanographic features critical to pelagic fish distributions around the Hawaiian archipelago. (Gary Mitchum and Jeffery Polovina)

This project will use satellite altimetric measurements of sea surface height variations to describe, and eventually to monitor, mesoscale ocean variations that are relevant to pelagic fish distributions. The emphasis on altimetric heights is warranted because these data are available almost continuously. This is in contrast to ocean color and sea surface temperature measurements which are blocked by the cloud cover often associated with the Hawaiian Islands.

Initially, the altimetric heights will be used to describe the statistics of the ocean mesoscale variability, which includes features such as eddies and fronts. Sea surface heights from numerical models will be used, along with available ocean color datasets, to diagnose the causes and effects of these features, respectively. Once the statistical description is completed, it will be compared to similar statistics computed for the pelagic fish distributions to determine the types of features that are possibly relevant.

In the later stages of the project, the altimetric heights will be used to identify specific mesoscale events and to correlate these with the fisheries logbook data to evaluate the success of the altimetric data in capturing the important types of mesoscale fluctuations. This information can then be used to remotely monitor the relevant mesoscale features.

A multilevel and mulitobjective programming model of Hawaii commercial fisheries. (PingSun Leung, Stewart Nakamoto and Ujayant Chakravorty)

Funding for this project was received at the University in January 1995. Three research assistants have been recruited. Because the project involves working with the Western Pacific Regional Fishery Management Council (WPRFMC) to quantity their preferences among multiple objectives, the Analytical Hierarchy Process (AHP) is being used for this purpose. Staff have spent some time researching the Council's multiple goals, and in thinking about ways to incorporate them formally in the AHP interview process. Currently a test run of the AHP is being performed on staff at the NMFS Honolulu Laboratory. Concurrently, a list of interviewees from the Council and industry is being prepared, which will serve as a proxy for the Council, members of which are based in different locations across the Pacific.

Simultaneously, an elementary fleet profit maximization model has been developed, This model obtains the economically optimal profit (i.e., profit maximizing) number of boats for any hypothetical fishery. This model assumes that as the number of boats in a fishery is increased, the fishing cost per unit of catch also increases. This model is currently being updated to represent the major fishing areas in the Western Hawaiian Seas and their stock and species characteristics.

The fishing boats are also being broken down to individual classes depending on size. Travel costs to each fishing area are also being explicitly incorporated in this optimization model. Preliminary runs of the AHP should be compete by the end of summer 1995. By that time the fleet behavior model is also expected to be complete. These two elements will then be combined into a non-linear optimization program.

A tag and release program for the Hawaiian seamount yellowfin and bigeye tuna handline and troll fisheries. (Kim Holland)

Activity to date has consisted of the prerequisite steps prior to actual commencement of fieldwork. "Scooping" sessions with interested fishermen have been held and compensation and other terms of participation have been discussed. A fisheries assistant, based on the Big Island, has been recruited. Tagging supplies have are on hand. Publicity posters and reward T-shirts are also on hand. A toll-free telephone number, 1-800-588-8066, has been established to simplify reporting of tag recaptures. Computer facilities to handle the tagging data have been upgraded. Software for manipulating tagging data has been kindly supplied by the South Pacific Commission. The first releases of tagged tunas are expected in July 1995.

Feasibility of airborne laser devices for pelagic fish surveys. (John Sibert and Christian Schoen)

The objective of the proposed research is to take a first step in an orderly, step-wise development of lidar for use in pelagic fisheries. The primary objective is to determine whether and under what conditions pelagic fish may be detected and identified using airborne laser devices. There is no doubt that submerged objects can be detected using airborne laser devices. It is not clear, however, whether different species of fish can be identified or to what depth in the ocean they can be detected. The proposed research will determine the target strengths of some commercially important fish species, whether these species can be distinguished from one another in lidar generated images, and the effects of other factors--depth, water clarity, surface state--might have on such discrimination.

Four artificial targets designed to represent the sizes of tunas and swordfish commonly caught by Hawaii longliners are under construction. Field work is scheduled to be completed by the end of July 1995. A final report will be completed by the end of the year.

Three-dimensional laser confocal microscopy as a tool to age fish otoliths by optical sections: validation of daily microincrements by both injected dyes and theoretical otolith growth models. (Robert Gauldie)

Funding for this project was received in February 1995. Laser confocal microscopy images of swordfish (*Xiphias gladius*) otoliths showed the expected array of microincrements. The MAC8100 computer, delivered in June 1995, coupled with SPY GLASS software has the capacity for volume rendering of otoliths from optical slices and the capacity for further analysis of arbitrary sections. Some start up difficulties with the system were encountered. Quantitative

analyses of otolith structure will begin in July 1995. The results will be used to devise improved methods for determining the age of swordfish.

Development of assessment model for western Pacific yellowfin (John Sibert and Pierre Kleiber), **and**

Stock and fishery dynamics of yellowfin tuna, *Thunnus albacares*, in the western and central Pacific Ocean: development of an integrated model incorporating size and spatial structure. (John Hampton and David Fournier)

This project will apply the SPARCLE model developed for south Pacific albacore to the analysis of yellowfin tuna and extend the model to include spatial variability. The SPARCLE model analyses length frequency, catch and effort data in an extremely flexible way and can accommodate multiple gear types, non-uniform sampling over time, and samples with part of the data missing. It is capable of estimating trends in population biomass independently of changes in gear technology. The new research will extend this approach to explicitly include spatial variability in population density and age (and size) structure. The geographic area to be included will encompass the entire range of the western Pacific yellowfin fishery including WPRFMC jurisdictions.

A numerical investigation of ocean circulation and pelagic fisheries around the Hawaiian Islands. (Bo Qiu and Pierre Flament)

A reduced-gravity numerical model of ocean circulation in the North Pacific ocean has been developed. The boundaries of the model are the North American continent on the east, the Asian continent on the west, the equator to the south and 38°N to the north. The spatial resolution of the model is variable and most detailed in the vicinity of the Hawaiian islands where the resolution is 1/12° of longitude by 1/10° of latitude. In its initial form the model is entirely wind-driven. Preliminary model runs, driven by mean climatological winds, show the major features of local circulation. To better represent the upper ocean changes around the Hawaiian islands, a 2.5-layer model is under development.

New PFRP Projects.

Five new projects were approved for funding in July 1995. Funds for these projects are expected to become available in September 1995.

The economics of recreational fishing for pelagics in Hawaii. (Kenneth McConnell and Samuel Pooley)

Some of the primary objectives of this project are to estimate the marginal economic value of catching pelagic fish by small boat anglers in the marine recreational sector of the main Hawaiian islands, to understand the substitution between pelagics and other fish sought by small boat anglers, and to assess the magnitude of the aggregate economic value of small boat fishing by sport anglers.

Genetic analysis of population structure in pacific swordfish (*Xiphias gladius*) using microsatellite DNA techniques. (Barbara Block and Carol Reeb)

This projects extends previous work on mitochondrial DNA which showed that pacific swordfish comprise a single genetic stock. Analysis of the short, repetitive, and highly variable sequences of DNA known as microsatellites has accurately linked individual to geographic location in some animals. This project will examine the use of microsatellite DNA for identifying the geographic location of individual swordfish.

Investigation of Pacific broadbill swordfish migration patterns and habitat characteristics using electronic archival tag technology. (Christofer Boggs and John Gunn)

The overall objective of this project is to develop knowledge and understanding required to provide scientific advice to the WPRFMC for the eventual management of North Pacific broadbill swordfish. Specific objectives include: determine seasonal large-scale, regional, and local horizontal movement patterns of swordfish needed for understanding fishery interactions; determine vertical distribution and diel vertical movement patterns needed for understanding catchability; obtain information on ocean thermal characteristics of swordfish habitat for understanding environmental influences on swordfish distribution and availability; and incorporate findings in models for understanding swordfish migration, movements, and habitat.

Geolocating archival tags have begun to provide detailed information on the movement and thermal environment of southern bluefin tuna (SBT). The development of these devices will be extended by integrating archival tag and satellite communications hardware to create a "pop-up" archival tag. The four core elements of these devices will include: 1) components from the Australian SBT archival tag; 2) and Argos platform transmitter to broadcast data to satellites; 3) a microprocessor controlled mechanism to release the device from the swordfish; 4) a solar power cell. The hardware and software contained in these devices proved the capability of logging data for up to five years, storing in non-volatile memory chips for up to 20 years, and, at a time specified by the user, transmitting summarized data to Argos receivers on NOAA satellites.

An assessment of bigeye tuna (Thunnus obesus) population structure in the Pacific Ocean, based on mitochondrial and microsatellite DNA variation. (John Hampton and Peter Grewe)

Assessment of the impact of increasing levels of bigeye exploitation throughout the Pacific by all gear types requires information on the homogeneity of the bigeye population. The objective this project is to characterize the genetic variability within and among samples of bigeye tissue collected from seven locations in the tropical Pacific Ocean: Philippines, Federated States of Micronesia, Kiribati, Hawaii, Tahiti, and the Eastern Tropical Pacific (2 sites).

Estimation of bycatch and discards of sharks and other species by the Hawaii longline fishery. (Xi He)

The target species of the Hawaii longline fishery are broadbill swordfish (*Xiphias gladius*) and tuna (*Thunnus* spp.), but large numbers of fishers with little or no commercial value are also

caught. The goals of this project are to develop procedures for estimating the amount and species composition of the bycatch, to understand the effects of fishing methods, area, and season on bycatch, and ultimate to estimate the impact on the blue shark population.